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**ENERGY RETOFITS IN SINGLE FAMILY HOMES, TOWARDS A  
HOLISTIC REGENERATIVE PROCESS.**

Masters Design Study in Sustainable Design - Part A  
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Master of Architecture – Post Professional  
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# ENERGY RETOFITS IN SINGLE FAMILY HOMES, TOWARDS A HOLISTIC REGENERATIVE PROCESS.

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**Abstract:** *Data on U.S. energy consumption and carbon emission stresses the importance of improving the current process of home remodeling in order to take advantage of the great potential offered by the existing housing stock. Home energy retrofits have gained increased popularity in the recent years. Yet, improvements are needed in order to get the most from these processes. In fact, energy retrofits occur in a way that is still too slow or too shallow. Furthermore, the retrofit industry approaches home assessments mainly relying on the use of technology and energy analysis tools. This method is limited inasmuch as it excludes social, cultural and personal variables from the assessment. This research investigates possible strategies to render the process of retrofit to be more holistic and long-lasting. Moreover, it investigates how the main obstacles that prevent homeowners from engaging in home energy retrofits can be removed and how the whole process can become easier and more accessible. Finally, it analyzes the relevant social groups that influence home energy retrofits and how their interactions shape this process.*

**Key words:** homes energy retrofits, home assessment, relevant social groups, Austin single-family homes.

# Table of Contents

List of figures.....	vii
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## 1. BACKGROUND AND PROBLEM STATEMENT

1.1. General Introduction.....	1
1.2. Definition of energy retrofit.....	4
1.3. History of energy retrofit in the U.S. and evolution of meanings throughout time.....	5
1.4. Retrofit as a continuous regeneration.....	6

## 2. DATA ANALYSIS

2.1. Energy Data.....	8
2.1.1. Energy Consumption and CO <sub>2</sub> Emissions.....	9
2.1.2. Residential Energy Consumption.....	14
2.1.3. Household Energy Use in Texas.....	15
2.1.4. Austin Energy.....	18
2.2. Housing Stock Data.....	20
2.2.1. Profile of existing housing stock (age and dwelling type).....	20
2.2.2. New and existing homes.....	24
2.3. Remodeling Industry Data.....	27
2.3.1. Current and future trend of home remodels.....	28
2.3.2. Characteristics of the remodeling industry in the U.S.....	30

### **3. METHODOLOGY**

3.1. Assumptions.....	32
3.2. Data collection.....	33

### **4. THE CASE OF AUSTIN**

4.1. Austin climate, housing stock and repair needs.....	35
4.2. Interviews to the Relevant Social Groups.....	37
4.2.1. Homeowners.....	41
4.2.2. Remodeling professionals.....	44
4.2.3. Designers.....	48
4.2.4. Policymakers.....	50
4.3. Case Studies.....	50
4.3.1. Home on West 8 <sup>th</sup> Street.....	51
4.3.2. Home on East 40 <sup>th</sup> Street. ....	55

### **5. CONCLUSION**

5.1. Introduction.....	58
5.2. Terminology.....	59
5.3. Data.....	60
5.4. The case of Austin.....	62
5.5. Findings.....	62
5.6. Business Plan.....	63

## **6. BIBLIOGRAPHY**

6.1. Home Energy Retrofits.....	67
6.2. Relevant Social Groups and users' behavior.....	69
6.3. Research Design and Methodology.....	69
6.4. Energy reports.....	70
6.5. Housing reports.....	71
6.6. Remodeling reports.....	71

## List of Figures

<b>Figure 2.1:</b> Total Energy Consumption in the U.S., Texas, and Austin compared with other countries.....	8
<b>Figure 2.2:</b> U.S. Residential Sector Energy Demand. Residential delivered energy consumption per capita in four cases (2010-2035).....	11
<b>Figure 2.3:</b> U.S. Residential Delivered Energy Savings in three cases. 2010-2035 cumulative differences from the 2010 Technology case.....	11
<b>Figure 2.4:</b> U.S. Electricity consumption 2012-2016.....	12
<b>Figure 2.5:</b> U.S. Electricity prices 2003-2015.....	12
<b>Figure 2.6:</b> U.S. Electricity consumption in homes by end use.....	13
<b>Figure 2.7:</b> Household energy use in Texas.....	15
<b>Figure 2.8:</b> Household energy use in Texas. Electricity only.....	15
<b>Figure 2.9:</b> Residential average monthly bill. Comparison between Texas, Louisiana and New York State.....	16
<b>Figure 2.10:</b> Profile of Austin Energy. Customers and energy sales (2013).....	18
<b>Figure 2.11:</b> Housing types in the U.S.....	20
<b>Figure 2.12:</b> U.S. Housing stock by age.....	20
<b>Figure 2.13:</b> U.S. Residential average square footage .....	21
<b>Figure n: 2.14:</b> European housing stock by age.....	22

<b>Figure 2.15:</b>	New privately owned housing units completed in U.S.....	23
<b>Figure 2.16:</b>	U.S. Energy consumption per square feet for owner occupied homes .....	26
<b>Figure 2.17:</b>	U.S. Consumption per square feet for owner occupied homes in different years of survey.....	26
<b>Figure 2.18:</b>	Quick facts on the U.S. remodeling industry.....	29
<b>Figure 4.1:</b>	Repairs and improvements needed.....	35
<b>Figure 4.2:</b>	Network of the Relevant Social Groups.....	38
<b>Figure 4.3:</b>	Relevant Social Groups Interviewed and Categories.....	40
<b>Figure 4.4:</b>	West 8 <sup>th</sup> Street Home, south façade.....	54
<b>Figure 4.5:</b>	West 8 <sup>th</sup> Street Home, interiors.....	54
<b>Figure 4.6:</b>	West 8 <sup>th</sup> Street Home, garage port.....	54
<b>Figure 4.7:</b>	West 8 <sup>th</sup> Street Home, view of the East side with the new addition.....	55
<b>Figure 4.8:</b>	East 40 <sup>th</sup> Street Home, main facade.....	56
<b>Figure 4.9:</b>	East 40 <sup>th</sup> Street Home, interiors .....	57
<b>Figure 5.1:</b>	Operational Diagram for an improved process of retrofit.....	65



## **BACKGROUND AND PROBLEM STATEMENT**

### **1.1. General Introduction.**

This report is the product of an independent study research project and constitutes the background research that anticipates my future Master of Design Study. The subject of this research is home energy retrofit, which is defined as a whole-building analysis and construction process that uses integrative design to achieve improved energy performance. My investigation focuses on how to design an effective system to promote retrofit interventions on existing homes in the Austin area. The goal of my inquiry is to design an organizational model that optimizes homes retrofit to meet the interests of homeowners, remodeling professionals, and the general public. In order to develop this model, I analyzed what problematic issues may arise when engaging in retrofit interventions and tried to evaluate what role these issues played in the feasibility of retrofits. The consequent deeper understanding of the existing problems and of the current conditions in which dwelling retrofits occur was of greatly informative. As a result I started outlining recommendations to develop a new strategy aimed at improving the way in which the different retrofit services are designed, planned and delivered.

The main research question expresses the primary inquiry that guides both this independent study and the future Master of Design Study. However, due to the limited time frame of a single academic semester, it was helpful to break down the broader main question into more defined secondary questions. Hence, for the purpose of the independent study three sub-questions have been more specifically taken into consideration: what are the main obstacles that prevent people who are interested in home retrofit from pursuing it, what are

the social relevant groups that shape the process of retrofit, and how are the necessities of a household assessed and evaluated. To answer these questions a variety of data was gathered and analyzed. The report comprises a series of interviews to stakeholders and two case studies, supported by relevant data, precedents, and literature. The complexity of this topic could not be resolved only by answering these few questions, but trying to react to these specific inquiries has been a very interesting and instructional exercise.

The structure of the report consists of five sections. The first section defines more concretely the problem of the investigation. The terminology regarding retrofit is investigated. The significance of each different term referring to a remodeling action slightly varies depending on the term itself. Here the goal is not to deeply analyze the existing jargon. Rather, it is to show how choosing the right wording is important because each definition (i.e. refit, refurbishment, conversion) reflects a different set of priorities and scopes which are not of interest for this research. Therefore the term retrofit, as it will be used throughout the whole report is defined within this context.

Homes are accountable for most of the energy consumption and CO<sub>2</sub> emissions in the U.S. Dwellings offer a great opportunity for reducing consumption but we have yet to take full advantage of this opportunity. The data shown in the second section seeks to display the scale of retrofit opportunities in the U.S. A picture of current (and future) status of energy consumption and CO<sub>2</sub> emissions, of housing stock, and of the remodeling industry is provided.

In the third section, the methodology used for the research will be illustrated. This research has been developed in the context of the City of Austin so its results are specific to this location. Yet these findings can offer improvement suggestions for dwelling retrofit in

the U.S. as a whole. A series of interviews conducted with homeowners, contractors, designers, remodeling companies, and representatives from the City of Austin and Austin Energy accompanied the previously gathered data. These interviews are not intended to represent a consistent demographic of Austin residents. Nonetheless they exemplify the different attitudes toward domestic retrofit from the perspectives of the various stakeholders.

In the fourth section, the City of Austin is analyzed in more detail. An overview of its climatic situation, housing stock and energy profile is provided. The relevant social groups will be identified and defined. The results of the interviews conducted with these stakeholders will be reported. The goal is to offer the perspective of each separate group in regards to some common retrofit-related topics. Finally two case studies of single family homes in Austin will be presented. Both these projects are examples of recent domestic energy retrofit interventions, yet they are quite different in scope and execution. They are of great interest as they show two completely different approaches to home energy remodeling.

Finally, the last section of the report tries to tie together some conclusions identifying areas of improvement for the current retrofit process. It presents findings and suggestions which open the floor for further research on the topic. This information will be used during next semester to design a business plan to guide the improved process for home energy retrofit.

### **Main Research Question.**

*What organizational model will deliver holistic and long-lasting home energy retrofits that optimize the interests of homeowners, remodeling professionals, and the general public?*

### **Sub-Questions for the Independent Study Research.**

- What are the main obstacles that prevent people who are interested in home energy retrofit from pursuing it?
- What are the social relevant groups that influence home energy retrofits? How do they interact among each other's and how do they shape the process of energy retrofit?
- How are the homeowners' necessities evaluated and assessed by professionals? What factors are taken into account (technological, social, and personal)?

### **1.2. Definition of Retrofit.**

The Oxford English Dictionary defines the word retrofit as:

- To furnish with new or modified parts or equipment not available or considered necessary at the time of manufacture;
- To install new or modified parts or equipment in something previously manufactured or constructed;
- To adapt to a new purpose or need (Oxford English Dictionary).

In other words the term retrofit is used to express an improvement of some sort, or a technological upgrade applied to a system, in order to enhance performance and functionality in the context of changed conditions. However these definitions refer to retrofit interventions as finished actions. I personally feel that such static

characterizations fail to underline the great potential of retrofit which is precisely contained in the repetition and continuity of the actions over a period of time. For this reason in this research I want to expand the Oxford definition into a more active one that sees retrofit as a comprehensive strategy for engaging a continuous regeneration of the built environment. Furthermore in the context of this study ‘energy retrofit’ shall mean an intervention aimed at improving the whole energetic performance of a building. Remodeling projects that have a purely aesthetic goal are not taken into consideration. Only projects with a clear goal of improving energy efficiency and thermal comfort will be considered. Also my analysis is not limited to a specific category of intervention, but in order to stress the importance of understanding retrofit as a holistic process, I will consider all the home systems jointly (water, energy, envelope, solar thermal, appliances, HVAC ...).

### **1.3. History of energy retrofit and evolution of meanings throughout time.**

Retrofit is not the only term used to indicate the improvement of existing buildings with new parts that are more technologically advanced. In fact adaptive reuse, renovation, remodeling, and restoration are different terms which have been often used interchangeably. The term “originated in the United States in the late 1940s and early 1950s, being essentially a blend of the words, *retroactive* (applying or referring to the past) and *fit* (to equip)” (Dixon and Eames 2013). Here my goal is not to go deeply into individuating nuances and differences between each term. What I believe to be interesting is to observe how the meaning associated with these terms has evolved over time. Forty years ago retrofit was intended more as an aesthetic action aimed to renovate

the style, enlarge the rooms or to beautify the interiors. In the late seventies, with the oil crisis the retrofit projects became more oriented towards improving homes energy efficiency. The term kept evolving throughout the years and so did the range of actions that were considered part of a retrofit project. Especially in the last decades retrofit has increasingly been associated with the concepts of sustainability and regenerative design (Cole 2012; Plaut & Dunbar 2012). A wider variety of issues (water, landscape, materials quality, CO<sub>2</sub> emissions) acquired relevance in the most recent renovation projects. Furthermore the values of these interventions have been extended outside the house itself to embed the social and cultural values of whole communities (Wölfling 1999; Roderick 2004). A neighborhood filled with distressed homes is not attractive, vital and healthy as one where each home is inhabited and well maintained. Also a neighborhood where retrofit is pursued as a continuous regeneration tool over time, has the double advantage of maintaining its typical character while reaching the highest standards of energy efficiency (Dunham-Jones 2011).

#### **1.4. Retrofit as a continuous regeneration.**

Building retrofit can be interpreted in different ways but in my opinion thinking of it as a continuous process of regeneration of the built environment is what makes it more valuable. In order for it to be considered a continuous process of regeneration it must at least embed three qualities:

- Continuity and maintenance. A retrofit should not be considered as a onetime intervention but it should be treated as a lifelong series of different measures directed to the betterment of the built environment, or as Dixon and Eames put it: ‘it is a mix of

incremental improvement and disruptive innovation in the built environment' (Dixon & Eames 2013).

- Integration. Retrofit must be thought of as a holistic intervention that considers the totality of the home components. Only approaching the house as a whole system it becomes possible to prioritize and decide the interventions to undertake.
- Personalization. Each family nucleus has specific needs and uses the home in very different ways. In order to increase success of the intervention and reduce the rebound effect all these habits should be taken into account. The one size fits all approach can bring some general improvements but a deeper amelioration happens when the users engage the new systems and contribute to their efficiency through behavior (Tweed 2013).

To conclude I would state that using the appropriate terminology is important as every term implies a slightly different set of actions and goals. Retrofit is the word that best expresses the characteristics and type of operations that are of interest for this research. The word shall mean a holistic intervention, aimed at achieving higher energy performance and greater comfort through an integrative design approach. In the section that follows a series of data will be presented. By showcasing current needs and possible opportunities, this data emphasizes the importance of increasing the scale of home retrofits in Austin and in the U.S.

## 2. DATA ANALYSIS

### 2.1. Energy Data.

In this section current and projected data regarding energy consumption and expenditures will be presented. This data provides a better understanding of the energetic profile of the US in general, and more specifically of the State of Texas. Finally some data related to City of Austin will be analyzed. However more information specific to Austin will be necessary to expand this section. This section wants to depict more clearly the context, on a national, federal, and municipal level, in which energy retrofits currently happen. Throughout the whole report total general energy consumption is showed in British thermal unit (Btu) which is the standard utilized in all the DOE/EIA publications. However the standard unit of electricity production and consumption is always expressed in kilowatt-hour (kWh). The relationship between kWh and Btu is

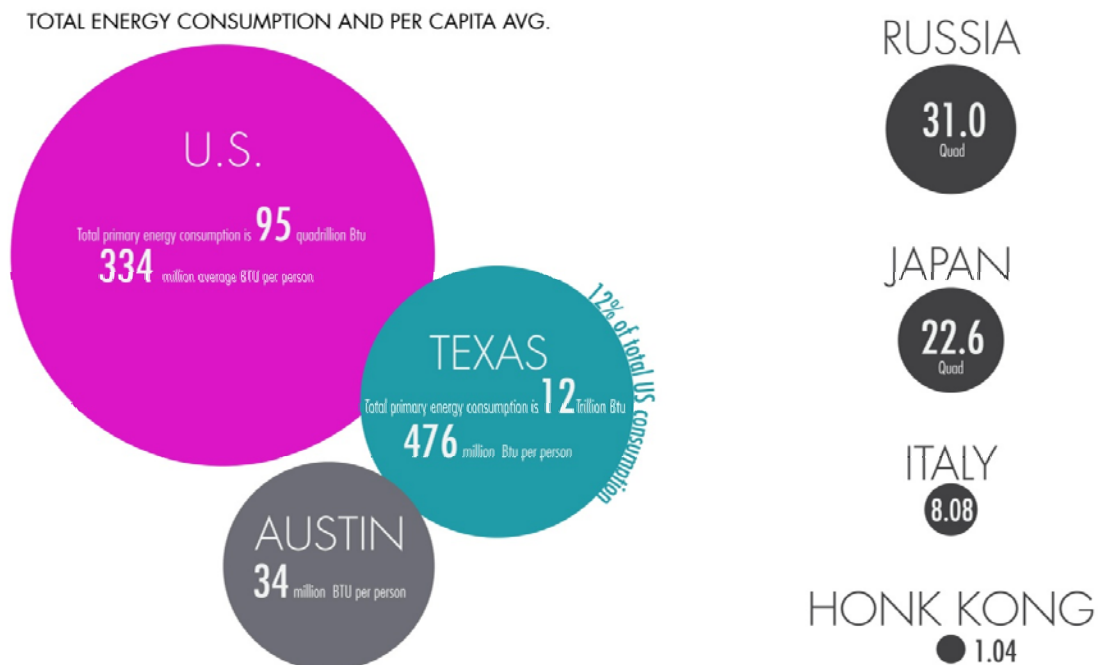


Figure 2. 1. Total Energy Consumption in the U.S., Texas, and Austin compared with other countries.  
Source: EIA 2013. <http://www.eia.gov/>



expressed as: 1 kWh = 3,412 Btu. Also, when describing national or global energy budgets, large-scale units based upon the joule, Btu, and kWh will be used (Quadrillion Btu or the Terawatt-year).

### **2.1.1. Energy Consumption and prices.**

Buildings in the U.S. today consume 72% of total electricity produced, and 55% of U.S. natural gas. U.S.'s approximately 132 million existing homes account for 20% of total U.S. energy consumption and greenhouse gas emissions. In a future where the limitation of natural resources will force governments and cities to find better solutions for density and efficiency, intervening on the built heritage and on the existing infrastructural system becomes crucial. The U.S. is among the states with the highest primary energy consumption (U.S. E.I.A. Historical Statistics 2010) ranking second only behind China. Figure 2.1 shows the total energy consumption of the U.S. and relates it with the total consumption of other countries in the world. The goal is to offer an interesting perspective on the scale of U.S. consumption worldwide. The total primary energy consumption in the U.S. (population of 313 million people) is equal to 95 Quadrillion Btu each year, which is about three times more than Russia (145 million people) and four and a half times more than the total consumption of Japan (127 million people). Statistics from the U.S. Energy and Administration Information agency reveal that the per capita consumption of U.S. energy has been almost consistent from 1970 until today. The 2011 EIA Annual Energy Outlook with projections up to 2035 (AEO 2011) suggests the possibility of a reduction of the energy consumed during the next twenty years (Figure 2.2). In the reference case, delivered energy use stays relatively

constant while population grows by 26.7 percent during the period. Growth in the number of homes and in average square footage leads to increased demand for energy services, which is offset by better construction, and by efficiency gains in space heating, water heating, and lighting equipment. The residential energy use per capita will vary depending on the end-use technology adopted. Three additional case scenarios are plotted on the chart. The 2010 Technology case assumes no technological improvement beyond what is currently available. The two other case scenarios, high technology and best available technology, assume in different measures the use of more advanced technologies during the future. However the greater efficiency improvements offered by the latter solutions seem quite optimistic. Another interesting graph from the same outlook exemplifies residential savings related to the adoption of not only new and implemented technologies, but to the combined action of these technologies and of energy standards and codes joint together (Figure 2.3). As for electricity specifically, the last EIA Energy Outlook Short-term report shows that the level of consumption in the last few years followed a growing trend which is likely to stay consistent in the future (Figure 2.4). While future electricity consumption seems to remain almost constant, electricity prices follow a different path (Fig.2.5). In the last decade prices in cents per kilowatt hour have steadily increased and this tendency doesn't seem to change. However when comparing U.S. prices with other countries worldwide it is possible to note that electricity in North America is still considerably less expensive. For example the average cost in Europe is around 25 cent/kWh, which is between two and a half/three times more than the U.S.

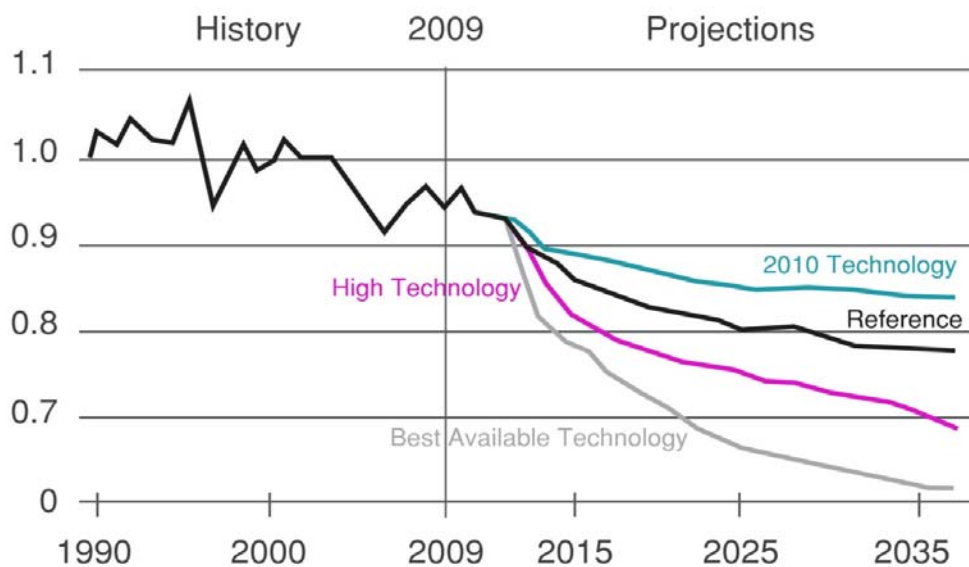


Figure 2.2 Residential Sector Energy Demand. Residential delivered energy consumption per capita in four cases (2010-2035).

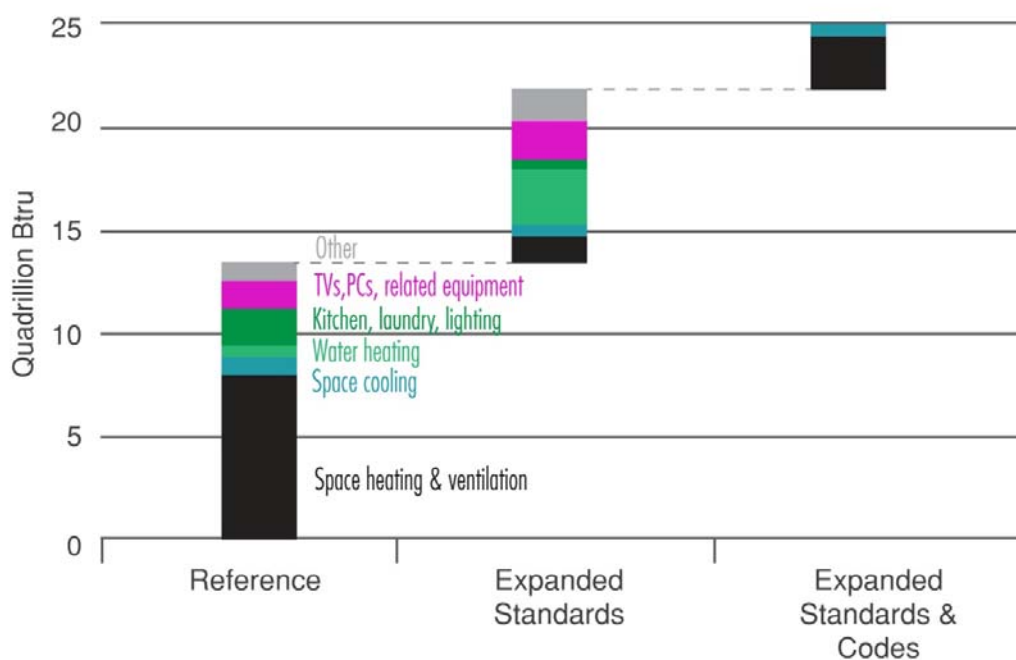


Figure 2.3 Residential Delivered Energy Savings in three cases. 2010-2035 cumulative differences from the 2010 Technology case.

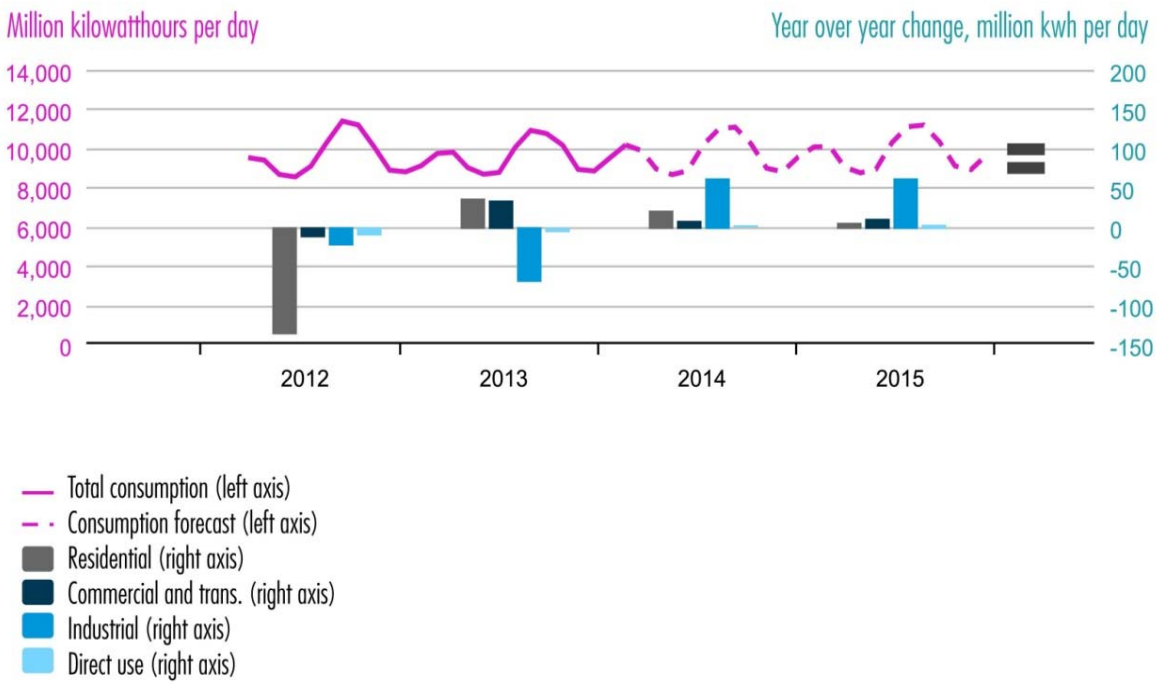


Figure 2.4. U.S. Electricity consumption 2012-2016. Source: Short-Term Energy Outlook, February 2014.

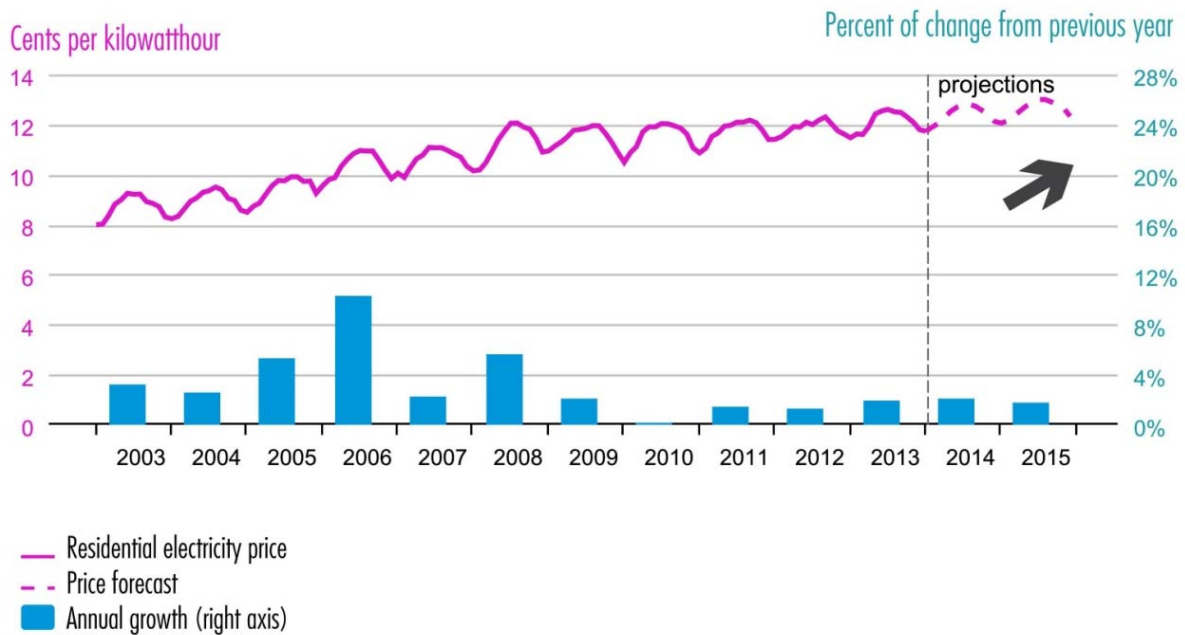


Figure 2.5 U.S. Electricity prices 2003-2015. Source: Short-Term Energy Outlook, February 2014.

### 2.1.2. Residential Energy consumption.

Space heating and cooling have always accounted for the majority of energy usage in houses but recently improved technologies for room conditioning and insulation provided a sensible reduction of heating and cooling loads. However, an always increasing number of appliances and electrical devices are now plugged in our homes. The pie charts in Figure 2.6 show how the energy usage accounted for appliances grew up from 24% in 1993 to 35% in 2009. At the same time space heating decreased from 53% to 41.4%. Nevertheless the total consumption in Btu from 1993 to 2010 has remained stable around 10 Quadrillion Btu. In fact the higher number of electronic devices (2+ laptops, TVs, etc...) counterbalanced the reduction of space conditioning keeping the total amount of energy usage the same. The bar graph at the bottom of these pie charts shows domestic energy expenses by fuel. What emerges is that most of the

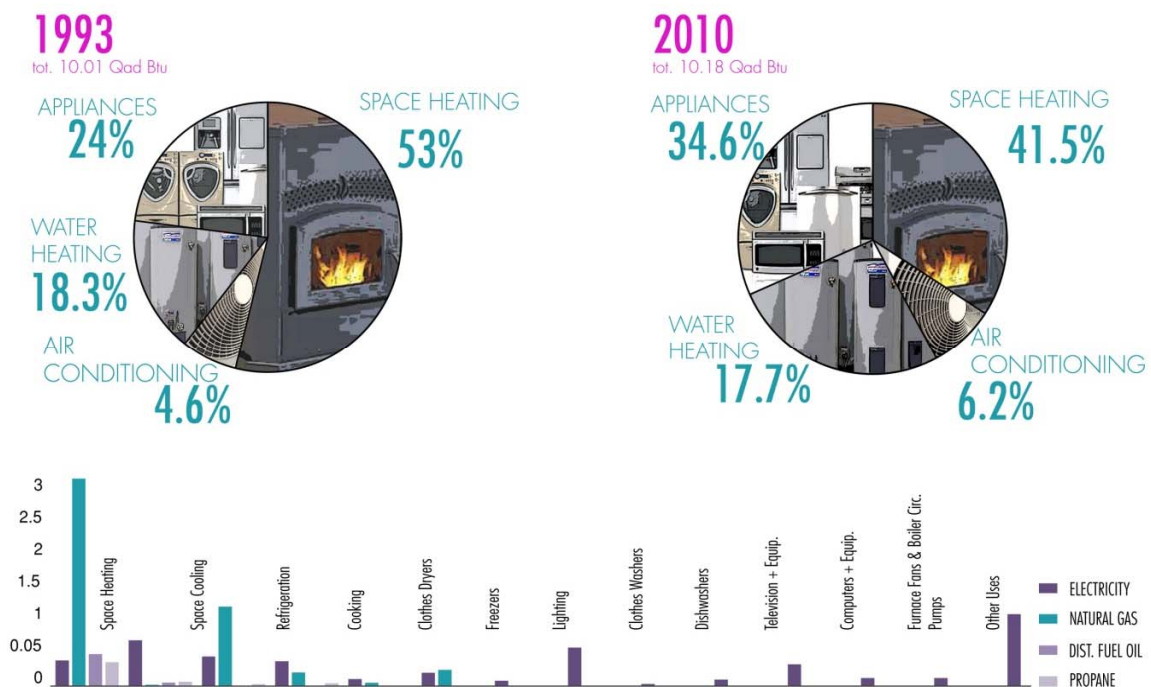


Figure 2.6. U.S. Electricity consumption in homes by end use. Source: U.S. Energy Information Administration, Residential Energy Consumption Survey.

energy consumed in a home relies on electricity while a small amount of natural gas is used, generally limited to space heating. Hence in the last decade the shift in energy end use (from space heating to electrical appliances) did not impact the total Btu but it implied a steady increase in electricity loads.

### **2.1.3. Household Energy Use in Texas.**

Now that a clearer picture has been drawn for the energy profile of U.S. homes it is interesting to look more specific at Texas. Figure 2.7 shows Texas household energy use in comparison with the U.S. and with the South West Central States: Louisiana, Arkansas, Oklahoma (or SWC as the Census defines them). Texas households consume an average of 77 million Btu per year, about 14% less than the U.S. average. However the lone star state shows higher levels of consumptions related specifically to electricity. The average electricity consumption per Texas home is 26% higher than the national average, but similar to the amount used in neighboring states (Figure 2.8). The average annual electricity cost per Texas household is \$1,801, among the highest in the nation, although comparable to other warm weather states like Florida. Yet Texas prices can be considered medium-low in respect to the rest of the U.S. state. The utility bills from New York, Texas and Louisiana have been compared (Figure 2.9). New York and Louisiana have been chosen because they respectively have the highest and the lowest electricity prices in the country. New York State has the most expensive rate (in cents per kWh) at 17.62 cents with about 7 million customers and an average monthly consumption of 603 kWh.

Louisiana is among the states with cheapest electricity price at 8.37 cents and counts circa 2 million customers. However the average monthly consumption is double of New York State with a monthly average of 1.250 kWh. As a result the average monthly bill for families in these two states ends up being very similar, about \$105. Texas electricity price can be considered relatively cheap on a range of 11 cents. The state accounts for almost 10 million customers but the average monthly consumption is close to 1.100 kWh.

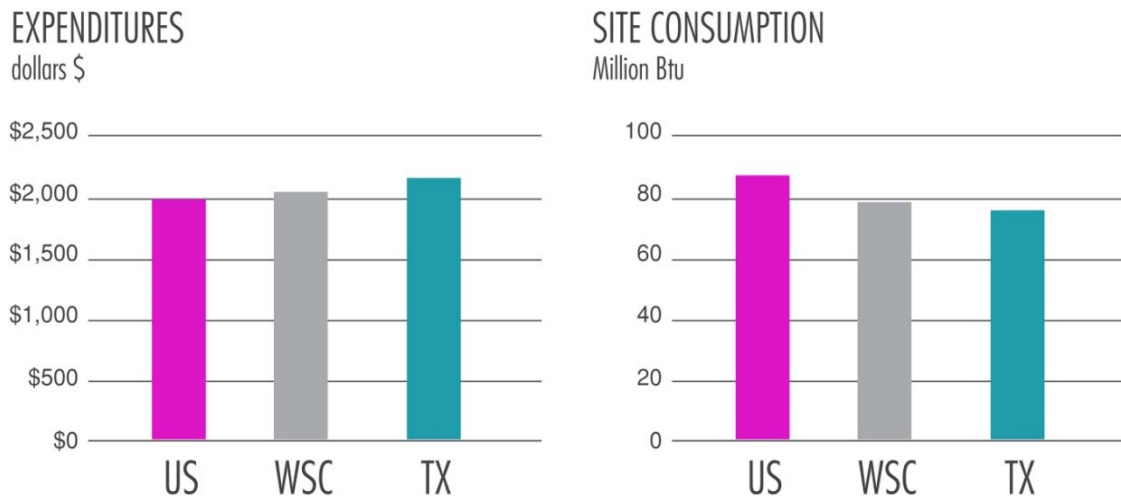


Figure 2.7. Household Energy use in Texas. Source: EIA's 2009 Residential Energy Consumption Survey [www.eia.gov/consumption/residential/](http://www.eia.gov/consumption/residential/)

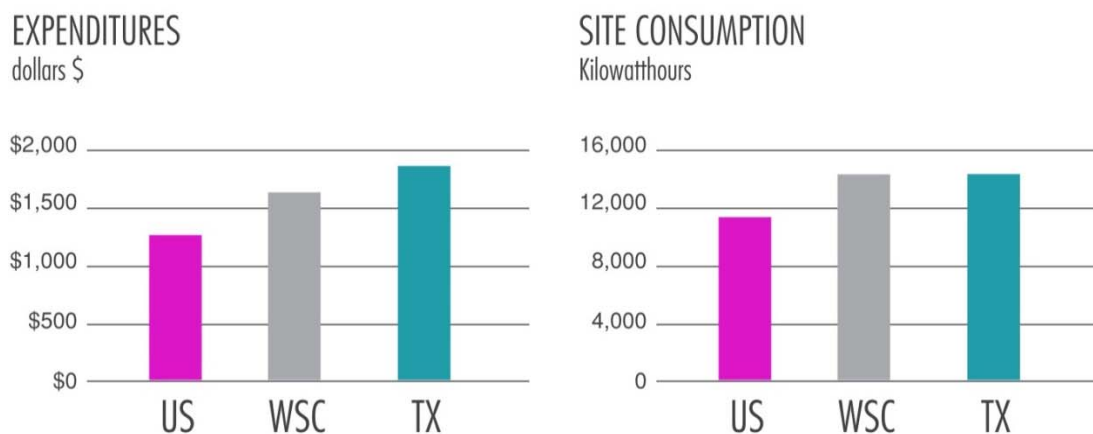


Figure 2.8. Household Energy use in Texas. Electricity only. Source: EIA's 2009 Residential Energy Consumption Survey [www.eia.gov/consumption/residential/](http://www.eia.gov/consumption/residential/)

So with only two more million customers, Texas consumes 50% more than New York State and its customers generally pay higher monthly bills (130 dollars). The higher amount of electricity consumption can be ascribed to Texas high number of cooling degree days which demand high use of HVAC systems. While cooling systems still run on electricity, heating equipment is often fueled by natural gas which is cheaper. But this can justify only in part why electricity expenses are so high in Texas. Perhaps the perception of abundant resources available mingled with the specific culture of this place play a role in forging a life style that tends to be unconsidered when it comes to resources consumption.

It is interesting to see that Texas has a substantial impact on the country in terms of energy matters (for both generation and consumption). The state is fifth in a rank of U.S. states for total energy expenditures and it is sixth in the rank for energy consumption per capita (476 million Btu). Furthermore Texas is the number one state in terms of energy

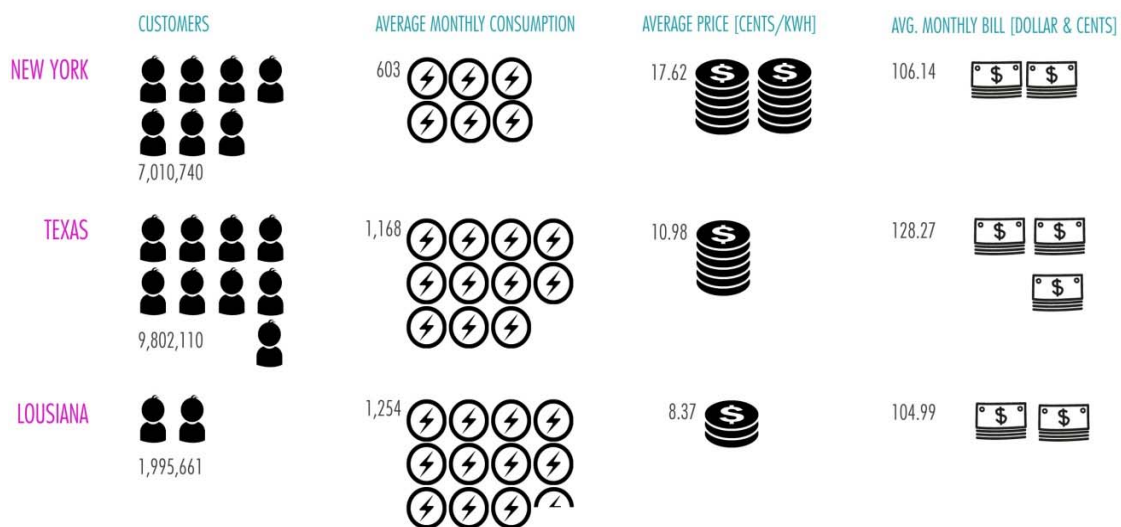


Figure 2. 9. Residential average monthly bill. Comparison between Texas, Louisiana and New York State.  
Source: EIA's 2009 Residential Energy Consumption Survey [www.eia.gov/consumption/residential/](http://www.eia.gov/consumption/residential/)



production (16.2 % of total U.S.) which makes it also very relevant regarding CO<sub>2</sub> emission levels.

#### **2.1.4. Austin Energy.**

Finding specific information regarding electricity consumption in Austin has been challenging. Austin Energy which is the municipally-owned utility company serving the city publishes a variety of reports to inform citizens on its general profile. However in none of those it was possible to find data indicating total energy consumption in Austin. In my personal view, the utility has played an important role in promoting programs for green building, weatherization, and home repair. This sensibility towards incentivizing sustainability, places it among the most forward-thinking companies in the U.S. However its programs of rebates and incentives are no exempt from confusion, missed opportunities and need for improvements. Austin Energy is a municipal utility serving a total of 368,700 customers. Of these customers, 89% are residential, 10, 4% is constituted by commercial, and only 0, 10% is industrial. Average electricity price is 9.90 (cents/kWh) however in the last years the utility introduced a different pricing strategy based on price tiers related to consumption.

Austin Energy launched a series of energy savings programs especially for existing buildings (PowerSaver, ECAD ordinance, Green Choice, and Plug-In Austin) and a Green Building program mainly for new construction. In particular the ECAD ordinance and PowerSaver program are of interest. The Energy Conservation Audit and Disclosure (ECAD) ordinance requires energy disclosures for all homes and buildings within the Austin City Limits that are served by Austin Energy (Austin Energy, 2013). This

## AUSTIN ENERGY PROFILE

Entity	Austin Energy
State	TX
Ownership	Municipal
Customers (Count)	378,873
Sales (Megawatthours)	4,241,660
Revenues (Thousands Dollars)	420,073.0
Average Price (cents/kWh)	9.90

Source: 2012 Utility Bundled Retail Sales- Residential  
(Data from forms EIA-861- schedules 4A & 4D and EIA-861S)

## AUSTIN ENERGY CUSTOMER PROFILE

	TOTAL	%
RESIDENTIAL	368,700	89.10%
COMMERCIAL	43,489	10.40%
INDUSTRIAL	80	0.10%
OTHER	1,601	0.40%

Source: <http://austinenenergy.com/wps/portal/ae/About/reports-and-data-library/data-library/energy-use-and-sales>



## ENERGY USE AND SALES

### Residential Average Monthly kWh and Average Bills

Year	Month	Average kWh	Fuel Charge (Cents/kWh)	Bill
2012	January	882	3.615	74.03
2012	February	663	3.615	58.48
2012	March	683	3.615	60.44
2012	April	731	3.615	65.13
2012	May	865	3.615	84.81
2012	June	1175	3.615	120.7
2012	July	1304	3.615	135.64
2012	August	1380	3.615	144.44
2012	September	1281	3.372	132.98
2012	October	871	3.372	80.31
2012	November	735	3.375	66.37
2012	December	659	3.372	58.57
Average Annual kWh		936	Average Bill	90.16

Figure 2.10. Profile of Austin Energy. Customers and Energy Sales. 2013. Source: <http://austinenenergy.com/>

ordinance requires that before the sale of their home, owners of a residential building must disclose an energy audit performed on the property. This is very important as it will affect sellers as well as buyers, and real estate professionals. The ordinance is a first step towards promoting the creation of consistent energy portfolios for buildings. Also by incorporating efficiency into the relevant parameters considered to establish the building's market value, it has the power to leverage the adoption of energy retrofit on a bigger scale. The *PowerSaver* program on the other end offers money incentives through rebates or special loans to undertake small replacements or home improvements. The program includes HVAC systems, solar photovoltaic, solar water heater, ENERGY STAR® products and appliances (heat pump water heaters, pool pumps, refrigerators). This program targets different systems but mostly aims at ameliorating efficiency

through smaller interventions and shallower measures. These ordinances, programs and rebates initiatives altogether have contributed to revitalize domestic energy remodels in Austin. The higher demand together with tax credit reductions induced many remodeling professionals to engage with Austin Energy programs and to adjust the nature of their businesses to target more specifically energy efficiency remodeling. Yet, much remains to do to target energy retrofits in a deeper and more strategic way throughout the city. The topic of energy retrofit is deeply interconnected with real estate and housing matters which will be outlined more in detail in the following section.

## **2.2. Housing Data.**

The data provides an overview of the current status of the existing housing stock in the U.S., Texas, and Austin. Building ages and typologies are analyzed together with rates for new buildings construction. This information helps in identifying the potential that the current stock offers for energy improvements.

### **2.2.1. Household characteristics (age and dwelling types).**

Almost 70% of the total U.S. housing stock is composed by single-family homes, 25% is composed by apartments and the remaining is represented by mobile homes (Figure 2.11). Hence individual homes must constitute the core of residential retrofits investigation. The EIA Residential Consumption Survey (EIA 2009) compares housing data relative to the US, the West South Central States (or WSC as the Census defines it) and Texas altogether. In terms of housing types, Texas and West South Central States follow the national trend with single-family homes constituting the majority of the

stock. Yet compared to the rest of the country Texas has a younger housing stock with only 5% of the homes built before 1950 (pre-1950 homes represent 20% of the U.S. total stock). Twenty percent of Texas homes were built between 1950 and 1969 while the rest of the residential units were all completed in the last four decades (Figure 2.12). Austin's owner occupied housing stock contains a larger proportion of units built before 1970 (21%). Fifty percent of the units were built in the 1970s and 1980s; however, a slightly higher proportion of owner occupied units were

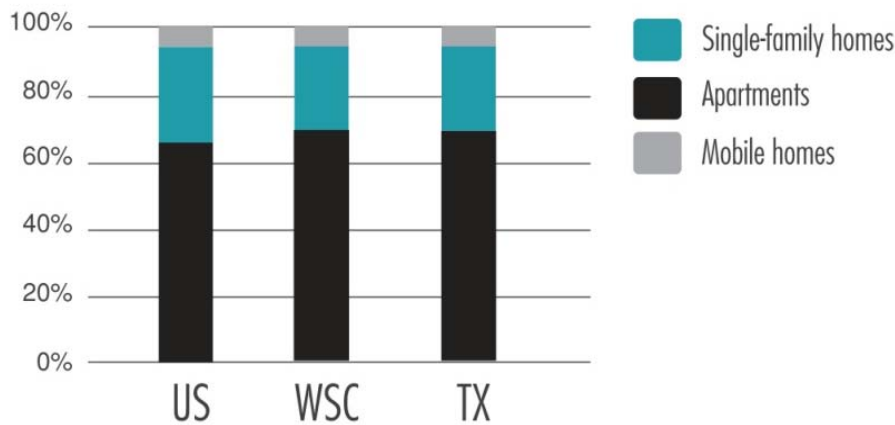


Figure 2.11. Housing types in the U.S. Source: EIA's 2009 Residential Energy Consumption Survey [www.eia.gov/consumption/residential/](http://www.eia.gov/consumption/residential/)

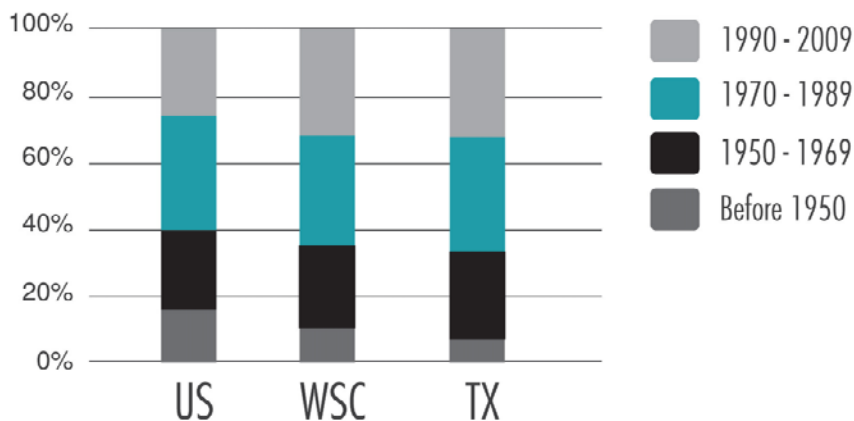


Figure 2.12. U.S. housing stock by age. Source: EIA's 2009 Residential Energy Consumption Survey [www.eia.gov/consumption/residential/](http://www.eia.gov/consumption/residential/)

built in 2005 or later, most likely to meet the residential demand (BBC, 2009). But the U.S. share of stock is relatively young when compared to Europe. Here a substantial amount of existing dwellings is older than 50 years with many buildings in use today that are hundreds of years old. More than 40% of European residential buildings have been constructed before the 1960s when energy building regulations were very limited (Figure 2.14). For this reason many European countries have long been concerned with their aging dwelling stock (Dixon et al. 2014). Even if American culture, building technology, and housing characteristics are different, looking at the experiences of European countries can still offer helpful suggestion to start considering the future role of current housing stock.

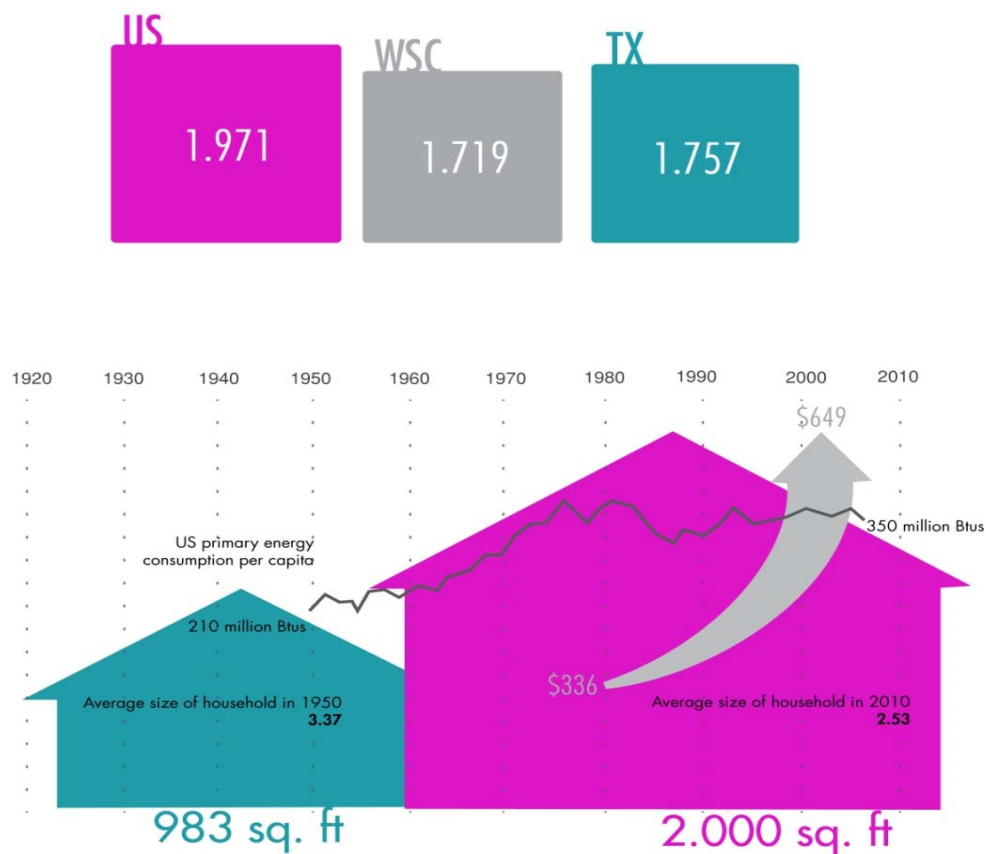


Figure 2. 13. Residential average square footage (U.S.). Source: EIA's 2009 Residential Energy Consumption Survey ([www.eia.gov/consumption/residential](http://www.eia.gov/consumption/residential))

A survey from BBC Research & Consulting (BBC 2009) shows data regarding the distribution of housing stock specifically in the city of Austin. Here only 50% of the people live in single family homes which is 20% less than Texas average. Excluding very few in mobile homes the remaining people live in apartments (10% in duplexes/triplexes; 8% in townhomes or condominiums). In 2009 the average household size in Austin was of 2.39 people. Owners have slightly larger average household sizes (2.56 people) compared to renter-occupied units (2.24 people). Also average household size varies greatly by race and ethnicity. For example a Hispanic household has an average size of 3.29 people, as compared to a much lower size of 2.07 for white households. During the last sixty years the size of the household in the U.S. diminished from 3.4 people to 2.5 people on average (Figure 2.13). Yet the size of American homes has steadily increased. In 1940 the average home was 980 square feet while in 2010 it was about 2.000 square feet. Texas average square footage is close to the national average which is equal to 1.970 square feet.

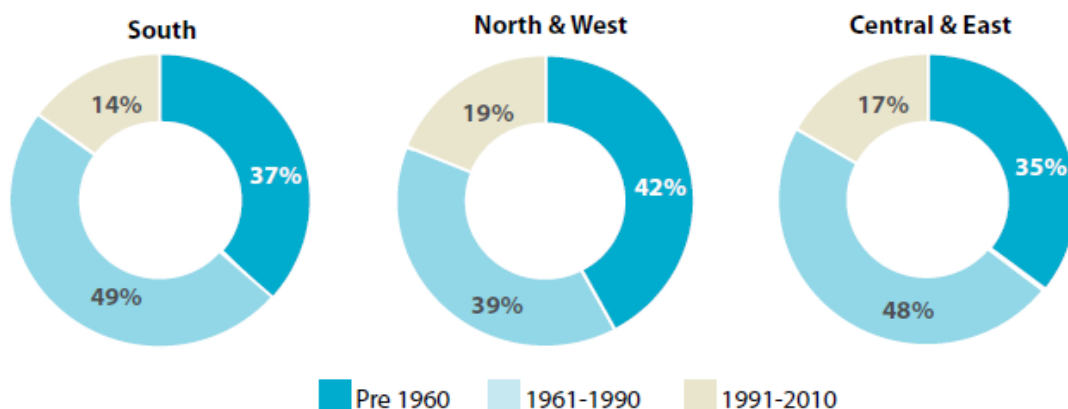


Figure 2.14. European housing stock by age. Source PBIE Survey.

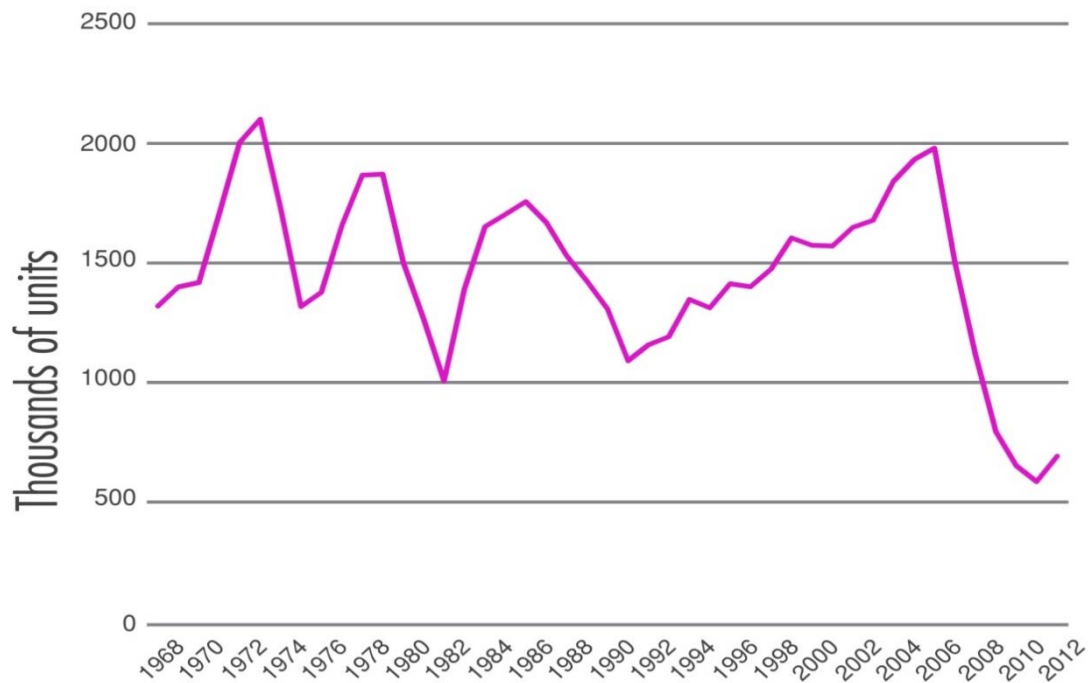


Figure 2.15. New privately owned housing units completed in U.S. Source: U.S. bureau of the Census 2010.

### 2.2.2. Current status of new and existing homes.

Recent studies from the U.S. Census Bureau show that between 2005 and 2012 the number of completed units in the U.S. dropped by more than one thousand units (Figure 2.14). In the last decade Southern States had the higher percentage increases in housing units (Texas saw an increment of 22.3%). But despite these higher rates performed by Southern states, the general number of new homes completed in the country follows a very slow pace. Similarly in Austin household growth has slowed during this decade, as compared to the previous one. Following the economic downturn housing starts were down 37% in third quarter 2008 compared to 2007 (Austin Business Journal). The city saw the addition of 7,350 households each year between 1990 and 2000, while 5,800 households have been added since 2000 (BBC 2009). In addition the

Census reports that in 2010 vacant units were 15 million or 44% more than in 2000. Furthermore, during this last decade the National Gross Vacancy rate (the percentage of vacant housing units to total housing units) increased by 2.4% nationally. Austin responded much better than other American cities to this freeze of new housing units. Yet the vacancy rate for ownership units grew from 1.5% (in 2000) up to 3.4% in 2008 in a tendency consistent with the national trend.

Building new homes more efficiently is of absolute importance, but these will constitute only as little as 20% of the total American housing stock in the next decades. As Itard et al. (Itard 2006) report: “in most [European] countries the number of buildings...renovated each year substantially exceeds the annual number of newly built dwellings. In most cases energy ambitions are an important reason to renovate.” However energy retrofit must happen at a higher scale because “measured against carbon reduction ambitions, it is typically too slow, too shallow or both” (McLaren, 2014). As a consequence to reach the goal of diminishing residential energy consumption and CO<sub>2</sub> emissions there is a need to rapidly intervene on the existing stock. The graphics on Figure 2.15 and Figure 2.16 (JCHS 2012) show the energy consumption of homes in relationship with their year of construction. The newest buildings consume less energy (a quarter) per square foot than those built before 1970s (Figure 2.15). On the other hand, older homes have tremendous potential for retrofits and energy savings. This can be observed on the bottom graph (Figure 2.16) which shows consumption rates and year of construction but for surveys completed in different years (1980, 1990, 2001, and 2009). What emerges is very interesting: older homes have greater opportunity for efficiency improvements and consumption reduction. For example a building built in 1940



originally consumed about 65 Thousands BTUs (1980 survey, pink bar) but in the 2009 survey (black bar) its consumption went down to 45 Thousands BTUs which is comparable with the consumption of newer units. Quantifying the real opportunity offered by retrofitting existing buildings is however complex. Numerous are the studies that try to investigate in what measure domestic retrofits are cost-effective and what is the payoff of certain interventions (Jones et al. 2013; Karvonen 2013). These investigations compare the results of whole-house deep retrofits with multiple shallower interventions to determine what is best to achieve maximum benefits and savings in relation to costs. But the bottom line is that there is no unique solution which is best. Rather these studies conclude that choosing the right combination of energy-saving measures accordingly to the needs of the homeowners and to the specific characteristics of the house is what matters the most for a positive outcome. In any case what appears interesting to me is that although in different measures and in different ways when retrofit interventions occur they are very likely to generate positive outcomes in the household (improved comfort, money savings, healthier environment, etc...). In the next section the remodeling industry will be analyzed more in detail and other studies referring to the potential of retrofits will be examined.

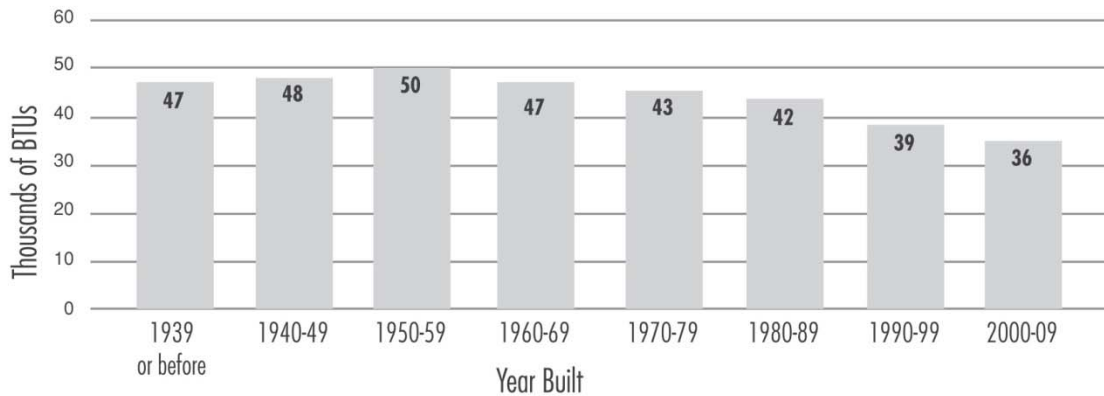


Figure 2.16. Energy consumption per sq. ft. for owner occupied homes (U.S.). Source: JCHS Tabulations of 1980-2009 RECS.

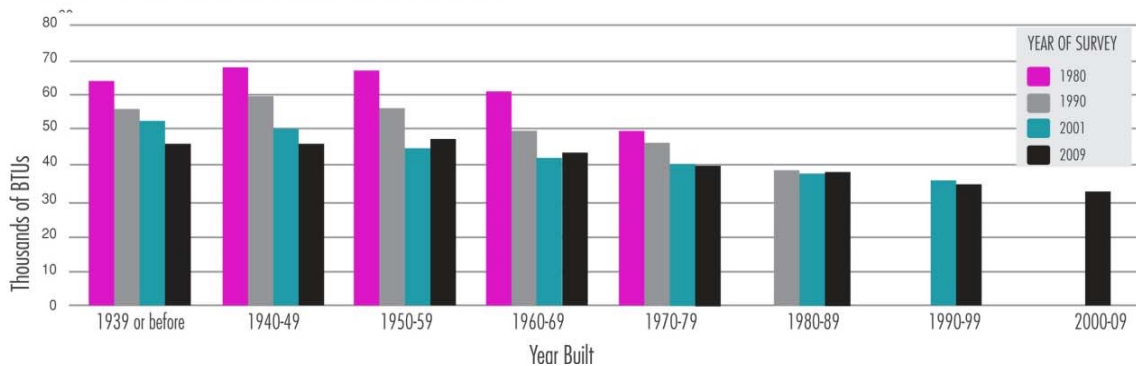


Figure 2.17. Energy consumption per sq. ft. for owner occupied homes (U.S.) in different years of survey. Source: JCHS Tabulations of 1980-2009 RECS.

### 2.3. Remodeling Industry Data.

Statistics on new buildings and construction are widely available and fairly accurate. Unfortunately this is not the case for data on home remodeling which exist in a less consistent and coherent form. The varying jargon referring to retrofits that was briefly discussed at the beginning of this report reflects a lack of coherence not only with terminology but also in surveys reliability. These studies are different in scope and aggregate different data depending on their purpose. In fact each surveying agency tends to deliberately include (or exclude) certain interventions depending on the goals of the

survey. This makes data comparison quite hard and its use must be careful (Rappaport and Cole 2003). In addition “there is little if not existing data on how people use the house nor before nor after the retrofit intervention” (Ravetz 2008).

### **2.3.1. Current and future trend of home remodels.**

Studies regarding home remodeling commonly refer to a variety of renovation processes but they hardly separate energy retrofits from the other interventions. In fact it is difficult to say how much of a renovation went specifically into efficiency improvements. The surveys used in this report broadly refer to home remodeling and include actions to improve efficiency and comfort as well as discretionary interventions and general upgrades. Even if this data doesn’t exactly quantify the impact of energy measures, it helps to better understand what the trends and the characteristics of remodeling interventions in U.S. homes are. The 2013 Report of the Joint Center for Housing Studies at Harvard University (JCHS 2013) states that 80% of home improvements are realized in owner-occupied homes while the rest occurs in rental units. Three quarters of total remodeling expenditures in 2013 went to improvements including replacements, upgrades, remodels, additions, and other operations intended to increase the value of the homes. The remaining percentage went to routine maintenance and repair projects aimed at preserving the current quality of the homes. Discretionary spending like kitchen and bath remodels or room additions make up for 25% of total expenditures, other miscellaneous interventions (garages, driveways, fencing, and patios) and interior upgrades (flooring, ceilings, insulation) make up for 22% and 12% respectively of the total amount of interventions. Replacements (roofing, siding, and windows) and system

upgrades (plumbing, HVAC, electrical) constitute the majority of the operations as they form 41% of the total.

Various studies have identified an enormous opportunity in U.S. residential remodeling interventions. (Dixon & Eames 2013; Harcourt, Brown, and Carey 2011). In fact it has been estimated that ‘large-scale retrofitting could yield US\$1 trillion of energy savings over ten years equivalent to the creation of 3.3 million cumulative of jobs years of employment’ (DB Climate Change Advisors; Rockefeller Foundation 2012). The Rockefeller Foundation report (Rockefeller Foundation 2012) also stated that “investments in residential energy efficiency upgrades can offer \$182 billion of investment potential, much of it in single family residential.” Furthermore the McKinsey report (2009a) concluded that “Energy efficiency offers a vast, low-cost energy resource for the U.S. economy... The residential sector accounts for 35 percent of the end-use efficiency potential.”

Despite these positive conclusions, there are other reports which expose a different and more pessimistic attitude. These studies question the feasibility and effectiveness of the energy savings investments displayed by McKinsey and others (Bardhan et al. 2013). In my opinion there are different obstacles that have so far prevented a greater and more rapid expansion of energy retrofits in homes. The fragmented and diverse nature of single family households is precisely one of these obstacles. But besides the problem of individuality there is also a deficient offer of financing strategies and a low effective level of demand due to scarce regulatory requirements. The challenges are undoubtedly numerous and of different nature. Yet the great potential for energy savings and emission

reductions revealed by our homes cannot be ignored and discarded simply due to the complexity of the current system.

### 2.3.2. Characteristics of the remodeling industry in the U.S.

To really have an impact on energy consumption and homes quality improvement, the scale of retrofit intervention has to grow and reach a more substantial presence on the market. While the top fifty home builders and the top fifty building materials and supply dealers produce huge yearly revenues; the fifty largest general remodeling companies generate less than 8% of total industry receipts (JCHS of Harvard University, 2013). Additional statistics on the remodeling industry show that two thirds of the remodelers are self-employed and that of all remodeling businesses with payrolls about two thirds are in specialty trades. Contractors, subcontractors, and other professionals involved in retrofit interventions are highly specialized and all mostly tend

The remodeling industry is **small in scale** if compared with other housing-related industries (home builders & building materials and supplies dealers).

**2/3** of home remodelers were self-employed.

The 50 top remodeling companies generated less than **8%** of total industry receipts (HB 40% and BM & SD 47%).

Of all remodeling businesses with payrolls in 2007, about **2/3** were in **specialty trades**.

High failure and **churn** rates especially of the small companies.

**Obstacles to growth** are: low barriers to entry, market volatility, highly customized and diverse work, and difficulty attracting capital.

Revenue for discretionary projects declined while replacements and **energy efficiency** improvements remained more stable.



Figure 2.18. Quick facts on the remodeling industry. Source: JCHS of Harvard University, 2011

to work independently. This means that the remodeling business is highly specialized and fragmented, generally inclined to a small scale than to a large one. In other words it shows to be still far from playing a dominant role on the construction market.

The data presented in this section evidenced that over the last decades the trend of energy consumption has been firmly on a high level. The savings obtained through improved building technology are actually offset by the increasing presence of electronic devices. Whether total consumption remained even, electricity has steadily grown. On the other side, housing stock statistics showed that the dwellings we live in nowadays are the same that existed thirty or forty years ago and that these will be around at least for the same amount of time. In addition, the amount of new completed houses drastically dropped in the last ten years. Therefore existing homes constitute the dominant presence in the housing market and represent the greatest opportunity for improvement in residential energy consumption and CO<sub>2</sub> emissions reduction. Statics relative to the remodeling sector highlighted the unfolding potential of this industry as well as the obstacles that are currently halting its growth. Its characteristic fragmentation and high specialization act as hurdles deterring an expansion comparable to other homes related industries (i.e. home builders, building materials, and supply dealers).

Considering the data altogether is possible to conclude that it is hard to evaluate what the exact measure of benefits produced by home energy retrofit is. However it remains clear that this process is not avoidable as the existing dwellings continue to age and will continue to play a crucial role in the years to come. New rebates and tax credit programs have incentivized the trend of energy efficiency improvements giving new stimulus to the remodeling sector. However in order for it to grow in scale there is a need for a

structural change in the industry and in the way its services are offered. Therefore higher coordination, more holistic services, and alternative managing strategies are needed.

### **3. STRUCTURE AND METHODOLOGY**

#### **3.1. Assumptions.**

The epistemological and ontological assumptions that I used for this research mainly employ a constructivist perspective which sees reality as subjective, specifically constructed, and context related. This independent research focuses on the U.S. and specifically on the City of Austin. The goal is to analyze home retrofit practices currently in place in Austin and to understand how these can be improved to make retrofit easier and more effective for both homeowners and remodeling professionals. The findings provide valuable information that can help generate new ideas to improve the current processes. The findings hold true specifically for Austin and its social, cultural, and economic systems, but they offer valuable suggestions also for the U.S. system in general.

This research stems from a personal belief that energy retrofit is needed and that is it possible. Despite the presence of multiple challenges and complexities, taking advantage of the opportunity residing in the current housing stock is a necessary action to lead the betterment of our living environment and the resource consumption reduction. At the beginning of this study I identified some challenges that seemed to possibly be preventing a wider growth of domestic energy retrofits. In particular I decided to target problematic issues related to the supply side. I assumed that the most common problems preventing homes retrofits occur because there is a lack of knowledge (from the demand

side), but also because there is high fragmentation and a lack of reliable, coordinated and personalized offer from the supply side. Finally I assumed that the way in which home assessments are conducted can be implemented to be more inclusive and sensitive towards local cultural character and personal needs. So, with this research I have not tried to investigate all the reasons why more people do not adopt energy retrofits. Instead I have gained a better sense of common problems afflicting the main relevant social groups in Austin. Consequently I have started thinking about how the service of home retrofit can be improved to reduce conflicts and become more reliable and accessible for the homeowners.

### **3.2. Data collection.**

This independent research relies on a variety of data and literature. The data regarding energy, housing and the remodeling industry was helpful to understand the scale of the topic and to contextualize it in the specific geographic location of Austin and Texas. The literature on sustainability, social behavior, green building, and retrofit offered precedents and a supporting theoretical background. Yet, a fundamental part of this research is comprised of a set of interviews collected from what were identified as the social relevant groups involved in the process of home energy retrofit. The definition of social relevant group will be explored more in detail in the next section. For now is sufficient to say that these people are homeowners, building professionals (contractors, builders, designers, remodeling companies), and regulators (Austin Energy or other City of Austin Departments) who offered their viewpoint on home energy retrofit. Semi-structured interviews were conducted with small representatives from all these groups.



These were used to identify retrofit motivations, challenges, priorities, desires and achievements. The survey sample is not intended to offer a comprehensive demographic for Austin. Rather it helps to understand what the perception of relevant stakeholders towards the challenges and problems connected with home retrofits is. The interviews consisted of no more than ten questions and were directed to a total number of 15 people: four homeowners, five professionals in the remodeling business (builder, contractor, photovoltaic systems, and remodeling company), four designers, and two representatives from City of Austin and Austin Energy. These people have been asked questions related to their personal and professional experience with home retrofits. They have been inquired about their perception of the current remodeling system and of the other stakeholders. These interviews have been coded and then organized into four general categories or topics that appeared to be common for all the groups. The scope is to summarize the opinion of each group regarding process of retrofit in general, challenges, perception of other actors, and expenses. The data from the interviews was then integrated with statistics, reports and case studies for the scope of this report.

#### **4. THE CASE OF AUSTIN**

##### **4.1. Austin climate, housing stock and repair needs.**

Austin has a humid subtropical climate with hot summers and relatively mild winters. It is usually sunny most of the year, receiving nearly 60.3% of the possible total of bright sunshine per year (Honk Kong Observatory, 2010). Daytime temperatures in summer are hot, with highs over 90 °F (34–36 °C) for about 80% of the time. The moderating effects of the Gulf of Mexico often limit daytime highs; however, they can

add to the discomfort with higher humidity. Precipitation is fairly evenly distributed throughout the year with heaviest amounts occurring in May and September. Hence the greatest climatic concern for Austin homes is constituted by very high temperatures often in combination with significant levels of humidity. Being predominantly a cooling climate with mild winters, it mostly demands retrofit measures related to heat protection, HVAC system and ducts upgrades, windows and doors sealing, roof improvements. In this climate good sealing of openings is more important than extremely air tight insulation.

In the third section the housing profile of Austin was introduced. In the last two decades the city saw a slowing down of new home construction and an increase of the vacancy rate which follows the State and national trend. However the slowing down for Austin has been less extreme than in many other major American cities. In addition, while average homeownership in the U.S. is around 65.1%, average rate of homes ownership in Travis County is less than 55%. Therefore Austin has a quite large renter population. This is composed by “temporary residents (primarily students), by individuals that chose to rent, and by those that simply cannot afford to purchase a home” (BBC Research & Consulting 2009). Affordability is an increasingly pressing issue and the high price for homes is especially limiting ownership. The Texas capital is a booming city and the statistics predict an enduring growth in the future years which will “put additional pressure on housing supply” (BBC Research & Consulting 2009). Together with the presence of numerous renters it is interesting to observe the household characteristics. In Austin the family household population comprises 52 % of the total and it is only slightly larger than non-family household population (48 %). This reveals

the presence of a quite lively housing market, with renters equaling the number of home owners and generating high rates of mobility. This could be a precipitous assumption but considering these facts together with the previously analyzed remodeling statistics (which showed that 80% of homes renovated are owned units) it would be interesting to observe if and how a low rate of ownership may influence or limit energy retrofits in Austin.

The BBC survey on the status of housing in Austin, interviewed homeowners and renters about repair needs (Figure 4.1). The results showed that renters are the ones who especially feel a need for home repairs (in particular in low income homes). The repair needs mostly involve windows and doors, painting, plumbing and roofing. However the table in figure 4.1 evidences how energy efficiency constitutes only a very minimal part of these improvements. In addition, the table highlights how the need for energy efficiency improvements is expressed solely by home owners while no sample from the

	Telephone Survey				Online Survey	
	Full Sample		Low Income			
	Owners	Renters	Owners	Renters	Owners	Renters
Accessibility modifications	1%	10%	2%	N/A	1%	0%
Air conditioning	3%	10%	2%	N/A	5%	6%
Appliances	1%	10%	2%	N/A	3%	10%
Bathroom	2%		2%	N/A	0%	0%
Electric	6%	10%	7%	N/A	7%	11%
Energy efficiency	1%		2%	N/A	11%	0%
Flooring	11%	6%	7%	N/A	8%	11%
Foundation	9%		11%	N/A	0%	3%
Insulation	5%	3%	0%	N/A	8%	5%
Painting	19%	7%	23%	N/A	11%	16%
Plumbing	9%	28%	9%	N/A	12%	9%
Roofing	11%	3%	9%	N/A	11%	5%
Siding	9%		7%	N/A	5%	4%
Water conservation	0%	0%	0%	N/A	2%	0%
Windows/doors	13%	13%	16%	N/A	15%	18%

Figure 4.1 Repairs or Improvements needed. Source: Austin Resident Survey 2008.

renters' population did mention them. This supports the hypothesis that the relationship between homeownership and energy retrofits can be somehow significant in a place like Austin. This report has focused mainly on finding ways to offer a better service to homeowners who are in need for home energy retrofits. However to scale up retrofit interventions in the context of Austin it will be necessary to adopt also other strategies to serve the needs of its vast renters' population. For more stable homeowners, energy retrofit represents a way to improve domestic comfort, reduce emissions, and cut costs.

However for renters and for all those homeowners who move more frequently, energy remodeling could represent a marketing strategy. Through retrofit it would be possible to increase the property value and to make it more desirable when it is inputted back into the market.

#### **4.2. Interviews to the Relevant Social Groups.**

A relevant social group consists of "all members of a certain social group [who] share the same set of meanings, attached to a specific artifact." "Institutions and organizations, as well as other types of organized or unorganized groups of people" may constitute a relevant social group (Pinch and Bijker 1987). Each group represents the particular interests of a specific category of people (i.e. consumers, users, or producers of a certain artifact or technology). Interactions among these groups shape certain processes or technologies and make them what they are. In other words "a problem is defined as such only when there is a social group for which it constitutes a *problem*."

Also, there is no one unique solution for that problem. Rather, as Pinch and Bijker pointed out “there is flexibility in the way things are designed, not one best way.” In other words, when a group of people who share a similar set of meanings, define something as a *problem* they will try to define a solution that is not the only possible one but is the one that best meets their specific interests. So the negotiation among and between groups is what shapes a certain technology or in this specific case, it is what shapes the process of retrofits as it currently is.

The process of home energy remodeling can be used as an example to describe the presence of different social group and the way they interact by shaping the process in order to pursue a solution that best meets their specific needs. First of all home energy retrofit is meaningful to the homeowners because it impacts directly their household and lifestyle. Then energy retrofit is meaningful to those who build and construct homes because they physically deliver the improvements. Furthermore, the policymakers will be interested in it because its adoption brings a reduction of energy consumption and CO<sub>2</sub> emissions that is beneficial to the community as a whole. The policies in turn will affect incentives or rebate programs offered by energy utilities (like Austin Energy). Also they will affect the way in which designers, realtors and other professionals in the

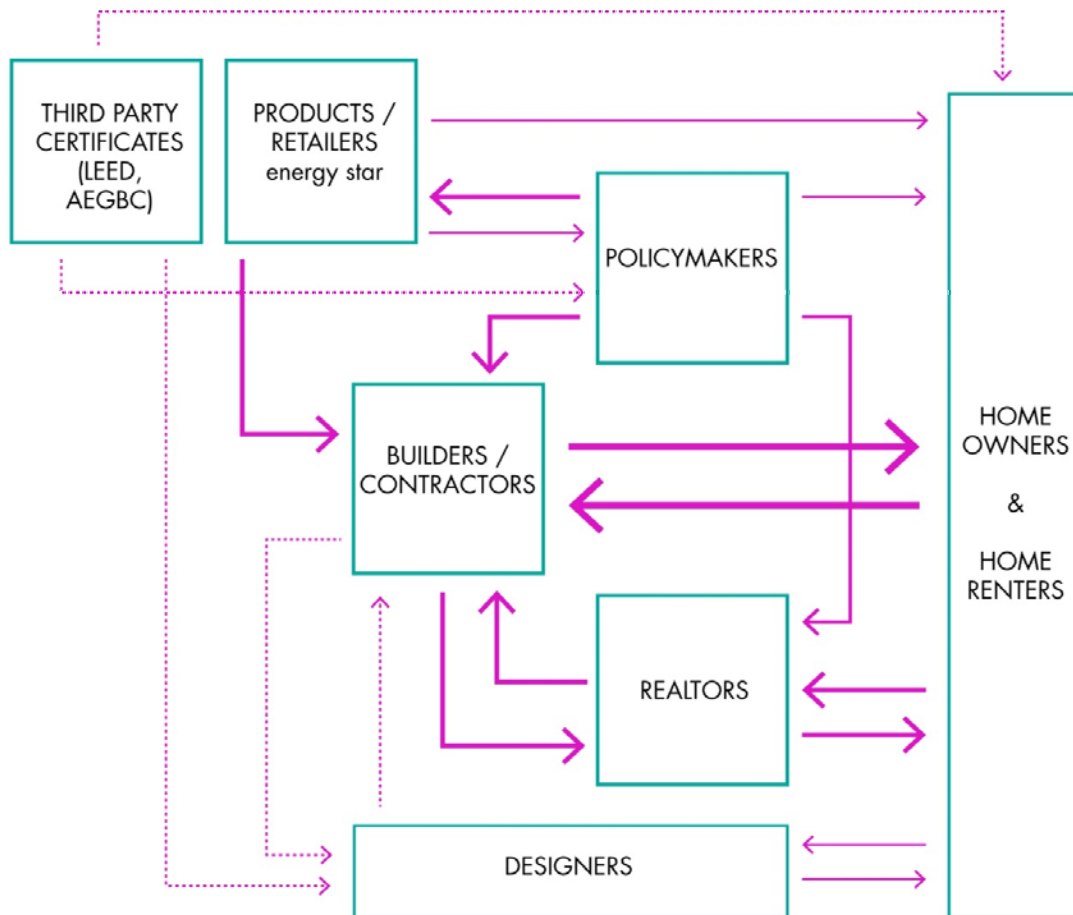


Figure 4.2. Network of the Relevant Social Groups.

building industry will decide to offer their remodeling services and what services to offer. At the same time those who produce and sell products targeted to high energy efficiency will also have a share of interest. Finally agencies offering third party certifications (i.e. U.S. Green Building, LEED, energy star) will be also interested in defining this process in a way that will be convenient for themselves. So the current process is not necessarily the only possible one for energy remodels to happen. Rather some of those groups have been more influential than others and gave it its current

structure as we know it. This network of actors is complex and it is not always easy to discern what the relationships of causality among the actors and their actions are. Sometimes different groups “act in what they believe to be their best interest but can produce effects quite different or even opposed to what they intended” (Cowan, 271). However trying to identify the groups who actually participate in this process is important. Recognizing what the interests at stake are for each of them can help better understanding why the process of energy retrofit in the U.S currently is shaped this way.

A first draft highlighting the network of involved actors is showed in Figure 4.2. The boxes representing each group have different sizes that represent the relative influence of that specific group within the network. What emerged from the interviews is that the process of homes retrofit is mainly contractor-driven as the contractors often establish priorities; decide what technologies to use and what actions to undertake. For this reason on the graph tries to emphasize the prominence of this group over the others. Moreover distinct line weights for the arrows connecting the different actors, express the degrees of authority of each link. The relationship between contractors and homeowners is among the strongest while the one between designers and contractors is generally weak and for this reason it is represented with a dotted line. As a matter of fact designers are rarely involved in energy retrofit projects especially when no layout changes are required. This network could be further developed and extended. Also a deeper insight needs to be gained regarding the strength and the directionality of the relationships among those actors. Yet, this was a great exercise to start observing the actors in place and to draw thoughtful connections between them. Due to time limitation, not all the significant actors have been interviewed. For the scope of this report four main groups

have been chosen: homeowners, building professionals (builders, contractors and subcontractors), designers, policymakers (or representatives from both the City of Austin and Austin Energy). This list could be further expanded and acquire different layers of complexity. However as for now these groups are good enough to represent the different perspectives of the main stakeholders involved in dwelling energy retrofits. The stakeholders have been interviewed regarding their personal experience with home retrofits. The surveys aimed at responding the sub-questions introduced at the beginning of this report. People where asked about the challenges they had to face when engaging in a retrofit, about their goals and expectations and about their perception regarding other stakeholders. Then the interviews have been coded and the results broken down into four categories: process of retrofit, challenges, perception of other actors, expenses (Figure 4.3). Creating these categories allows for an easier and more consistent comparison of the information collected from all the different subjects.

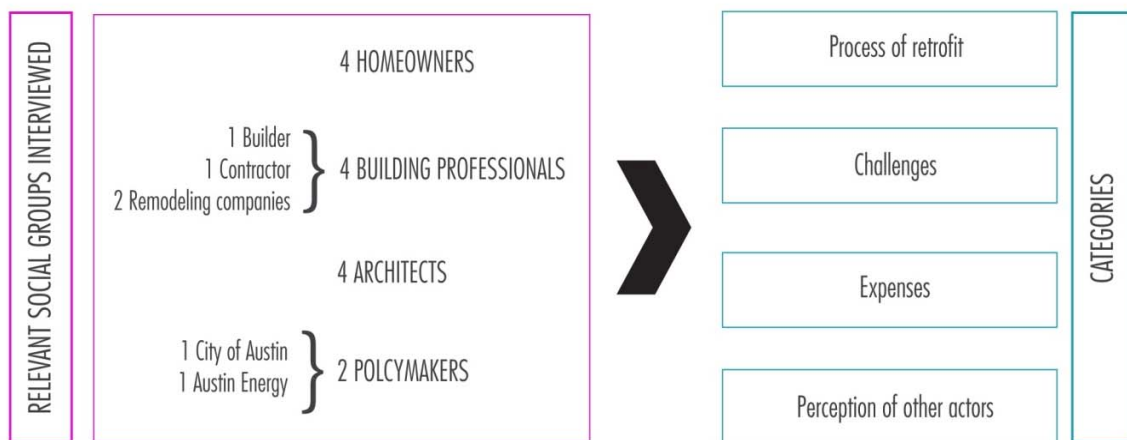


Figure 4. 3. Relevant Social Groups interviewed and Categories.



#### **4.2.1. Homeowners.**

Four homeowners were interviewed for this research. Their homes are located in different neighborhoods of Austin and they have resided there for a range of time varying between 3 and 15 years. Two of these homeowners have jobs related somehow to the housing sector while the other two do not. This is noteworthy as familiarity with housing-related matters played a significant role in their approach to energy retrofit. In fact the closeness of these homeowners to building professionals or designers instilled a greater sense of confidence in approaching the decision of undertaking energy retrofits in their houses.

- *The retrofit process.* Households' needs evolve throughout time and sometimes modifications of the existing space are required. Therefore the majority of homeowners at some point thought about remodeling the house they live in. What emerged from the interviews is that efficiency improvements are rarely the leading decisional factors triggering a home retrofit. Rather, they mainly happen as consequential aspects of the general project of home remodeling. However, for a smaller group of homeowners energy efficiency and consumption reduction were high priorities which strongly guided the remodeling project. Personal values and desires, education, and financial security were noticed to influence people's attitude and expectations towards the retrofit. For many homeowners domestic energy retrofit was a way to increase indoor comfort and to cut expenses while for others it represented a strategy to increase their property market value. Hence depending on the reasons that brought homeowners to begin a remodel, the objectives and final outcomes demonstrated to be quite diverse. One aspect is very interesting to observe: those homeowners that had no type of personal or professional

connections with people involved in the construction or housing industry were the ones who tended to procrastinate and expressed more insecurity to get started with a retrofit project. These interviewees knew that retrofit was ‘the right thing to do’ although at first they had no clue on how to proceed. This hints to the fact that increasing the general knowledge of this topic by sharing experiences with neighbors and friends could help other homeowners obtaining helpful information and gaining more assurance. Word of mouth and friends recommendations turned up to be the preferred ways used to select the professionals (although they were not always successful suggestions). What also emerged from the interviews is that often one few specific interventions (for example a photovoltaic or a water collection system) are perceived as the optimal solution for the success of a retrofit. This is emblematic of a behavioral tendency that prefers visible and more ‘sexy’ technologies against more effective but banal or invisible interventions (for example duct sealing). Visibility demonstrated to be a key element for homeowners as being ‘green’ is seen as a status symbol. People are justly proud of their retrofit project and want to be able to show the new features of the house to others, especially neighbors. For some of homeowners, especially when budget was not an issue, visibility determined the priorities of interventions. Whether for a lack of knowledge or for budget reasons a more holistic approach to retrofit is generally bypassed.

- *Challenges.* For most of the people interviewed the main challenges associated with energy retrofit were:

- ~ Lack of knowledge;
- ~ Quality of professionals and coordination during on-site work;
- ~ Bureaucracy and documentation;

~ Up-front costs.

The first obstacle for homeowners is to understand what types of interventions are needed in their home and how to go about finding reliable professionals. Homeowners are worried about poor quality of execution and about disruption due to construction works. A common issue affecting all their negative experiences was the presence of unforeseen problems. Most of the frustrating episodes were caused by troublesome relationships with the contractors or some of the subcontractors. In some cases the company or the contractor selected did not execute works of great quality which caused further disruption and great distress for the homeowners. Most of the homeowners said that they would pay a higher price for a service that guarantees a control of quality, efficiency and rapidity of execution. Most of the companies offering energy retrofit services in Austin do help customers calculating rebate and incentive prices. However understanding if they qualify for rebates and handling the paperwork and the documentation remains a concern for most of them.

- *Expenditures.* Most of the people interviewed had a more or less definite starting budget in mind. The home assessments and the consultations with the remodeling companies provided suggestions on what the interventions to undertake should be and how to prioritize them. However, establishing a realistic picture of the improvements' payoff was hard both for homeowners and for the professionals running the assessments. Some homeowners reported that the selected professionals after assessing the current status of the house prepared budget estimates that proved to be inaccurate. After the job was obtained these low up-front bids were inflated with 'unexpected' expenses to the disappointment of the owners.

- *Perception of other stakeholders - Designers.* In one way or another, all the homeowners interviewed had benefitted from the expert advice of a designer. Some had specifically paid an architect to supervise the ongoing works. Some others didn't pay a designer's services but still turned to designer friends to ask for recommendations and advices related to the project. The only homeowner who didn't take advantage of a professional designer has a degree in architecture and therefore is quite familiar with the building system of his house. Hence the competence of architects and designers is considered valuable by homeowners.
- *Perception of other stakeholders - Contractors & Sub Contractors.* As mentioned above, rough relationships with contractors and builders are often source of frustration for the homeowners. However when the project is carried out well and the homeowners are satisfied with quality and price they will tend to use the same company and to recommend it to other people.

#### **4.2.2. Remodeling professionals.**

A total of five professionals in the remodeling business were interviewed. Two work for remodeling companies that provide multiple services (HVAC systems, insulation, photovoltaic, geothermal, etc...). The other three are a builder, a contractor, and an expert of photovoltaic systems. The first two are specialized on different aspects of home energy retrofits. The builder and the contractor on the other end were more knowledgeable on general construction systems while the last professional has greater expertise specifically with photovoltaic technology. Learning from this sample of

professional has been very informative as each of these people is involved with a different part of the energy retrofit process.

- *The retrofit process.* Also within this category there are different attitudes towards energy retrofit and its meaning. It has been noted that builders and contractors operate with a broader goal of improving the existing conditions but tend to compromise a lot on deep energy measures. Instead, the other subjects belonging to specialized energy remodeling companies seemed keener on adopting deep measures for energy efficiency and sustainability. This is probably due to the slightly different nature of their businesses. For many of these professionals ‘up-to code’ seems a good enough standard. For this group of people, the simple act of upgrading part of the building with a newer component is enough to make it better. In these cases the code is also less restrictive. In fact since the remodeling interventions aim at upgrading or fixing only parts of a building it will not evaluate the parts that have not been touched.

- *Challenges - Code, permits, and inspections.* All the professionals interviewed had some complaints related either to permitting or inspections. The City of Austin, which is home of some of the most exciting and high tech companies, does not have a computerized system in place to process permits and manage inspections. Therefore the permitting process is time consuming and obtaining the necessary paperwork takes a long time. Regarding the inspections, the main complaint is directed to the lack of quality of control and a lack of consistency. During the development of each project different City officers will in turn be assigned to run an inspection. Having a different inspector visiting a site for the first time during each inspection slows down the process and doesn’t guarantee the consistency and accuracy of the inspection. Some professionals suggested

that each inspector would be assigned to a specific number of cases. In this way they will be able to follow those projects from start to end. Moreover they would be incentivized to deliver high quality inspection by being more engaged or compensated on a project by project basis.

- *Challenges – Bidding, quality VS price, education.* Professionals expressed the difficulty to make a bid for a project and to evaluate upfront what are the interventions needed and to estimate the costs for it. Remodeling offers a wide opportunity but it is not a high price point industry so estimating expenses and bidding correctly a project are very important actions. Communication with the homeowners is another issue especially expressed by the professionals working for the two remodeling companies. Convincing customers to spend money upfront to undertake certain interventions that will pay off in the future years is not always easy. Also educating them on how to use the new technology is crucial but not necessarily straightforward.

One thing that has been noted is that each company specializes with a series of technologies (for example spray foam) or with a specific type of that same technology (for example a particular brand of spray foam) so they will try to sell the technology they are more familiar with. This is to say that the services and prices that each company can possibly offer to customer are limited in some ways and the professionals tend to push some technologies rather than others.

- *Expenditures.* Specialized workers are very important and labor consists in one of the higher costs. Time is very expensive therefore finishing the works within the established time frame is very important especially when a loan has been requested. Some professionals recycle but generally it is too time consuming and in comparison

materials are available at a very cheap cost. Insurance and high overhead costs are other elements that weight on the expenses. It was interesting to note that most of these professionals are not big enough to get deals on materials and appliances purchases. Most of them shop at big stores like Lowe's or Home Depot. Some have learned to shop on line or to use craigslist.

- *Perception of other stakeholders - Designers.* Architects at times are involved because they are required to produce blueprints or drawings for permits. Yet, their input on a remodeling project is generally not held necessary unless big layout changes are needed. Some builders use computer software to produce the required blueprints on their own. In any case the general tendency is to avoid extra expenses to involve an architect or another figure that carries on a coordinating or managerial role as it is considered an unnecessary overhead expense. This reflects the fact that home remodeling is mainly a contractor-driven business and that other professional figures are not commonly involved in these projects.

- *Perception of other stakeholders - Homeowners.* Most of the professionals are asked by the customers about 'green building' or about 'efficient homes'. However, they are aware that only a small group of customers is really interested in engaging a more sustainable lifestyle and in monitoring the house energy performance. In many cases asking for a 'green building' or obtaining the AEGBC rating is more a status symbol or something to be proudly shown within the neighborhood.

- *Perception of other stakeholders - Policymakers.* Almost all the professionals think that Austin Energy is doing a fairly good job especially if compared with most utilities companies in the US. Their incentives and rebates revitalized the remodeling industry

and promoted the energy efficiency programs. However improvements are needed to keep these rebates and policies consistent throughout time and different financing and loan strategies are deemed necessary.

#### **4.2.3. Designers.**

Four local architects who have experience with retrofits have been interviewed for this research. Although they all focus on residential architecture, they tend to serve very different clients. Some work for non-profits so their daily job consists in an effort to combine sustainability with affordability and to get the best result with the smallest expense. Some others work for higher end clients so budget is not an issue. They are freer to experiment but at the same time have a hard time educating wealthier customers in engaging with energy saving measures. All of the interviewed designers have their own concept of what efficiency or sustainable shall mean and they always try to convey it into a new project.

- *The retrofit process.* What emerged as a frustration for most of the designers is the inability to accomplish all the interventions that were preset in a project. Most of them spent consistent amount of time to conceive creative solutions to insert energy efficient measures into a house. However many times those solutions have been abandoned in place of other interventions that had more of an aesthetic value. Prioritizing actions is complicated and will vary depending on the customer. For some wealthy homeowner saving \$5.000 each year in energy bills is not so relevant. For some others this saving would mean a lot, but the upfront costs to undertake all the necessary measures to reduce consumption are too high. And so often none of them ends up prioritizing deep energy



measures for their remodeling project. Designers who believe in the importance of these measures try to make a case for their importance but often fail to convince the clients.

- *Challenges.* One of the main challenges for architects is perhaps entering into a dialogue with a homeowner and to balance desires and expectations with budget limitations. In the specific case of energy retrofits, designers need to find clear ways to demonstrate what the beneficial pay off of would be for each intervention. Also they need to find a common language, free from too many technicalities, for communicating with customers. Also educating clients towards best practices for using the house is an important issue for designers. Finally architects often find themselves in competition with contractors or builders but their education is sensibly different. Unfortunately in the remodeling business their expertise is often considered unnecessary and the expenses superfluous. However in the cases where designers participated in remodeling projects by supervising and coordinating the whole process, best results have been achieved. This managerial and coordinating role is very important and beneficial to the quality of the project.

- *Expenditures.* Time and commitment are the greatest expenses for architects. Often they have to pay collaborators or consult other specialist to help and to follow up on a project. Modifications and changes occur all the time and they constitute an increase in expenses as well.

- *Perception of other stakeholders - Homeowners.* Architects often have to mediate homeowners' desires and expectations with budget limitations and possibilities. Each of the designers interviewed had different opinion about sustainability and energy efficiency based on their personal beliefs and education. Therefore, some of them

considered shallower interventions to be good enough for a general improvement of the house. In contrast others were convinced that only deeper energy interventions would be effective solutions. For most of these designers most of the frustrating experiences occurred when an original design, containing a series of deep energy features, was altered eventually removing most of those features. In the architects' opinion most of the wealthier customers demand energy efficiency features because they care most about being labeled as 'green'. However these households do not particularly care about money savings or about changing lifestyle to reduce residential consumption. On the other side, those customers who have a more modest income and would benefit most from energy savings, do not have enough money to contract an architect and they address contractors or subcontractors directly.

- *Perception of other stakeholders – Contractors and Builders.* Designers seem to have mixed feelings towards contractors and builders. This is because they believe that most of these professionals prioritize timeliness over quality of execution. Generally it emerged that architects do have some professionals whom they trust for most of their projects. In case they need a specialized subcontractor they use word of mouth to find and hire one.

#### **4.3. Case Studies.**

The sets of interviews conducted during the semester offered valuable insights regarding the perspectives of the different stakeholders involved in the process of home energy retrofit. In addition, the analysis of two specific case studies offered concrete examples of how those perspectives materialize in a real project. These single family

homes have been selected from different neighborhoods of Austin. One project, the East 40<sup>th</sup> Street home, is located in East Austin which is an area with a large population of minorities and generally lower income families. The other one, West 8<sup>th</sup> Street home, is located in Old West Austin which is a wealthy neighborhood whose demographic consists mainly of older, white people. The household composition of the two cases is also different: the house on East 40<sup>th</sup> St. is inhabited by a younger couple with two children; the other one hosts a slightly older couple living alone. These two case studies are interesting because they exhibit two different approaches to home retrofit. In the part that follow the case studies will be described more in detail, highlighting similarities and differences.

#### **4.3.1. Home on West 8<sup>th</sup> Street.**

This two story house shows characteristics of new Victorian style. The owners bought it about six years ago and moved in only after the completion of the renovation. The house was sub-divided into three smaller units. This subdivision was completely removed with a project that was not simply a remodel but included major interventions of addition and new construction. In fact only the envelope of the buildings was kept as it was originally while all the interiors and the addition on the north side are new. This case study doesn't represent exactly the type of interventions that are focal for this report inasmuch as it could be considered more a new construction than a retrofit. Nonetheless it reveals a specific approach to green building, energy efficiency that is interesting to observe. The owners hired a local architect to prepare the design. He provided the drawings and followed the project throughout completion of the construction works. This

is unusual because not many people can afford the higher expenses of contracting a designer to supervise and manage a project. However those services provided extremely valuable for the family who expressed satisfaction for the final result. The home is 3,500 square feet with kitchen, dining, three bedrooms, three bathrooms, an office and a new carport. The old shell was kept, the wood recycled, spray foam insulation was added to it and new single pane windows were put in place. Sun path studies and analysis from the designer directed the orientation of the new parts and the disposition of the openings. The owners were generally interested in having a home that would be efficient and 'green' but it was under the suggestion of their architect that they decided to pursue the five-Star Rating with Austin Energy Green Building Program.

The house features a 6.3 kW photovoltaic system on the new metal roof. The system is connected to the grid so the homeowners get credit back from the utility. However an interesting episode came up during the interview. During an electrical outage the family noted that all their appliances were not running. This made them realize that perhaps the system is not used in the home but it is simply selling energy back to the grid. The system that they own should generate enough power for their daily consumption and still have energy to sell back to the grid. But the fact that they are not aware of this is both surprising and very interesting. These homeowners had the best intentions and had no economical limitations for their interventions. Yet, their knowledge regarding their housing systems is minimal. They rely much on other professionals' suggestions in order to take decisions regarding the home.

This house is certainly beautiful and functional and for now deserves the green building rating. Anyhow it missed the opportunity to be equipped to be even more efficient and

resilient for the future. Finally the homeowners are missing the opportunity to fully engage with the building system and to learn some beneficial lessons by observing their habits.



Figure 4.4. West 8<sup>th</sup> Street Home , south façade.

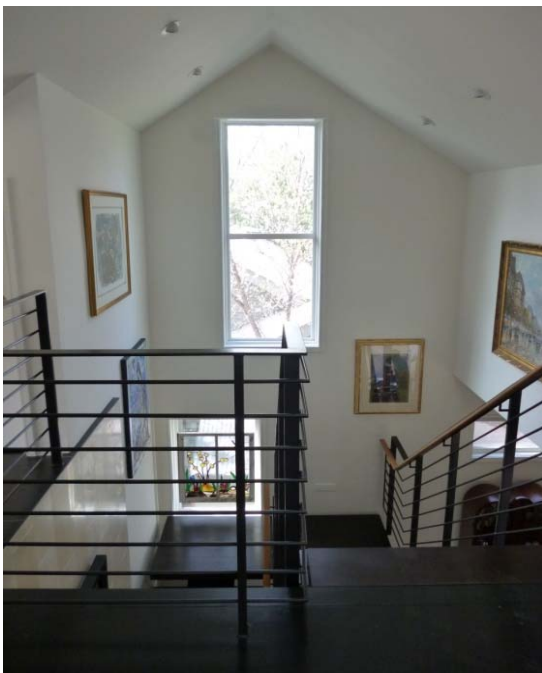


Figure 4.5. West 8<sup>th</sup> Street Home, interiors.



Figure 4.6. West 8<sup>th</sup> Street Home, garage port.





Figure 4.7. West 8<sup>th</sup> Street Home, view of the East side with the new addition.

#### **4.3.2. Home on East 40<sup>th</sup> Street.**

This 1948 one story ranch was bought by the actual owner in 2011. The older part of the house was renewed and two rooms and a studio were added for a total of 2,200 square feet. The old windows were replaced and rigid foam insulation was added to the original stucco walls. The attic has been sealed with spray foam and most of the equipment has been replaced. A new HVAC system (19SEER) was installed together with new ductworks and an Energy Recovery Ventilation system. In order to reach the Net zero goals all the systems (even space and water heating which traditionally run on natural gas) transitioned to electricity. Two solar hot water panels provide the necessary



Figure 4.8. East 40<sup>th</sup> Street Home, main facade.

hot water for the house and a 4.5 kW photovoltaic system produces all the necessary electricity.

After a very short time, the Net Zero goal was surpassed. In fact the home produces more energy that it needs and this surplus is either sold back to the grid or it is used to power the family's new electric vehicle. This house received the 5 Star Rating from Austin Energy Green Building Program and is starting an application for the Living Building Challenge Program.

This exceptional performance and attention to detail and efficiency was due to a main fact: the homeowner holds a Master's Degree in Architecture and works for a housing





Figure 4.9. East 40<sup>th</sup> Street Home, interiors.

nonprofit. His education and personal beliefs had the greatest impact on this remodeling project. For this homeowner it was not only a design exercise but an opportunity to realize a project of great value that at the same time has a minimal impact on resources. This home has a pedagogical intent for its users. Sixteen circuits (for the different pumps, for the HVAC, the electric vehicle etc...) are constantly monitored. In this way the owner can observe where the energy is going and how it is been used. As a result the family has been learning more about its consumption habits and has started to understand how to behave in order to change them.

A common element of these two case studies is the fact that both households expressed the intent to 'go green' and to be more efficient. Both projects have been

assigned a 5-Star Rating by Austin Energy Green Building Program. Although their budgets were different they aimed at doing the best with the available monetary resources. Finally for both the households the home status in the neighborhood was an important component. Despite these similar elements, the two projects had essentially different outcomes. The owners of the home on West 8<sup>th</sup> St. wanted to install energy efficient upgrades because they thought that it was ‘the right thing to do.’ However this intention did not match their lifestyle and the technologies installed did not change the way in which they engage with their dwelling. On the contrary, the owners of the House on East 40<sup>th</sup> St. started to monitor their consumption to know more about their behavior in the house and to understand how to modify it in order to cut consumption.

In conclusion, for the second family the house became an interactive learning tool but for the second household it remained simply a showcase of good intentions.

## **5. CONCLUSIONS**

This report looked at how to design an effective system to promote energy retrofit interventions on existing homes in Austin. It demonstrated that a better organizational model can be designed to improve the way in which the different energy retrofit services are currently designed, planned and delivered.

### **5.1. Introduction.**

The research started by observing how the process of retrofit currently takes place and trying to identify what its strengths and failures are. The goal was to understand what aspects of this process needed to be improved in order to increase the demand for

home energy retrofit. What emerged was that the challenges for a greater adoption of energy retrofits are numerous and of different nature. Complexity is high especially in the case of single homes where multiple individualities are present. But besides the problem of uniqueness there is also a deficient offer of financing strategies, of comprehensive quality services, and a low effective level of demand due to scarce regulatory requirements. In Austin it has been noticed that a market for energy remodeling is present, and that currently there are companies offering remodeling services targeted towards energy efficiency. However there is much to do in order to scale up the amount of these remodeling interventions and to impact more substantially the city's total energy consumption and CO<sub>2</sub> emissions.

## **5.2. Terminology.**

At the beginning of the report, the terminology referring to remodeling interventions was introduced. This was necessary as different words (refit, renovation, remodel ...) are often used interchangeably with retrofit. However, each term bears a slightly different meaning and refers to distinct interventions thus causing confusion. The lack of clarity existing with terminology is relevant as it relates to a lack of clarity among surveys and data. The absence of a univocal definition often makes it hard to compare the information in a consistent and reliable way. For the purpose of this study retrofit is defined as a holistic intervention, aimed at achieving higher energy performance and greater comfort through an integrative design approach. Moreover this process must own three important qualities: continuity, personalization, and integration. Continuity refers to the idea that maintenance and improvements should happen

continuously and be part of a building life cycle. Personalization refers to the fact that successful retrofit interventions happen when users are engaged and when the upgrades are based on the needs of each household specifically. Finally, integration calls for a whole system approach to the house, where users' behavior as well as all the technological building systems are taken into consideration.

### **5.3. Data.**

After introducing the question over terminology, the second section of the report presented some data related to energy consumption, status of housing stock and profile of remodeling industry. This data displayed information regarding the U.S. in general and more specifically regarding the State of Texas and the City of Austin. The goal was to depict more clearly the context, on a national, federal, and municipal level, in which energy retrofits currently happen.

The energy related statistics demonstrate that the U.S. is among the countries with highest energy consumption. U.S. residential consumption, in particular, has remained stable on a high level. The improvement of the building technology yielded higher indoor comfort and efficiency savings in the newer homes. Yet, the presence of a greater number of electrical appliances and wider use of air conditioning offset those efficiency gains. Hence, whether the total U.S. amount of energy used (Btu) remained stable, the total amount of electricity used (kWh) increased, as well as its prices.

The data on U.S. housing stock showed that the typology of single family home constitute 80% of the total residential buildings in the U.S. Only 30% of these homes have been built between 1990 and 2010, another 30% have been built between 1970 and

1990 while the remaining 40% is older than 1970. Moreover, during the last decades the rate of new units completed slowed down while the vacancy rate rose by 2.5%. As a result is possible to conclude that a vast number of existing homes is already in need of upgrades and remodeling interventions. Therefore energy retrofits will constitute a great opportunity to upgrade existing homes while cutting residential energy consumption and expenses.

Finally the last piece of data offered a picture of the dimension and the characteristics of the remodeling industry. This industry demonstrates to be extremely fragmented, full of specialized and self employed professionals. Compared to other building related industries it maintains a small scale as it generates considerably low revenues and faces higher churn rates. This fragmentation of the professional service and the small scale of the businesses are assumed to be among the issues impeding energy retrofit to scale up and gain more popularity.

#### **5.4. The case of Austin.**

Austin population has been constantly growing in the last years thus creating high demand for new constructions. Also, while in most of the American cities about 80% of the household population is constituted by homeowners, in Austin the household population is almost equally composed by owners and by renters. The remodeling statistics presented in section 2.3 showed that there is a relationship between home ownership and rate of retrofit as 80% of the retrofits interventions happen in owned homes. Therefore, since Austin has such high population of renters, it will be interesting to understand how and if this will impede a wider access to retrofits. The

recommendation is that, in the specific context of Austin, different strategies will be adopted to take into consideration not only home owners but also renters. These strategies shall aim at using energy retrofits as an opportunity to create an infrastructure of healthier, efficient and affordable homes.

### **5.5. Findings and case studies.**

Section four of the report presented the two case studies and the first findings of the research. Semi-structured interviews have been conducted with representatives of the relevant social groups that influence the process of home energy retrofits: homeowners, building professionals (builders, contractors and subcontractors), designers, and policymakers (representatives from both the City of Austin and Austin Energy). The goal was to present the different perspectives of the main stakeholders involved in dwelling energy retrofits. The interviews have been coded and the results broken down into four categories: process of retrofit, challenges, perception of other actors, and expenses. Through these categories it was possible to compare the opinions of each interviewed group regarding each of those matters.

A series of problematic issues and personal frustrations emerged from the interviews. These issues demonstrated to act as obstacles in preventing people's accessibility in home energy retrofits.

- **Knowledge.** When homeowners have some knowledge of the building system or are connected to reliable people who work in the building sector their level of uncertainty and insecurity towards retrofit is reduced and they demonstrated to be more likely to undertake a renovation project. For this reason it would be

beneficial to create open source educational tools or forums for people to share experiences and to learn about existing opportunities.

- Money & upfront expenses. Upfront expenses demonstrated to be a problem only for part of the homeowners while for others who had an allocated budget, finding help with prioritizing the necessary interventions constituted a greater issue. To understand the necessities and therefore to determine the priorities for each household demonstrated to be crucial. Most of the homeowners were more likely to accept those upfront costs when the professionals were able to draw future projections of uses and expenses of the house and to demonstrate that the energy retrofit would recover the costs through future efficiency savings and reduced maintenance expenses. In general, it is recommended to think about retrofit as a series of long term interventions of maintenance and upgrades.
- Fragmented offer and quality control. The lack of extensive coordinated services from remodeling companies constituted one of the main problems for homeowners who had to become their own general contractor. Many people stated that they would pay a premium to have someone in charge of the coordination and the management of the project. A guarantee of the services' quality is also currently missing. No official network of professionals exists and there is no way to verify their credentials. Word of mouth is still the preferred way to contract and engage workers.
- Disruption. Every homeowner had some negative experience with disruptions caused by construction in the house. Offering a more organized and

comprehensive service can help to implement coordination on site while completing the work in a more efficient and timely manner.

- Bureaucracy & documentation. Many companies already provide a service to calculate incentives and rebates for homeowners so production of the documentation did not emerge as a big issue. However understanding what possibilities are available to access loans and rebates remains an annoying and time consuming process.

To conclude it emerged that retrofit is a contractor-driven business. In fact architects or designers are rarely involved in energy retrofits projects while generally the contractors are in a direct relationship with the homeowners. Also, it emerged that homeowners' necessities are assessed mainly from a technological point of view and that social and personal factors are rarely taken into account. Professionals have not developed a good surveying strategy to engage more accurately with the way each homeowner uses the home. Yet, multiple studies have demonstrated that technology alone will not be enough and that a retrofit is really successful when people understand and interact with the new systems.

The case studies presented are two single family homes who undertook a deep energy retrofit. Both showcased a series of energy efficiency features which granted them a 5 Star Rating from Austin Energy Green Building Program. However the two projects display two quite different approaches towards home energy retrofit. The owners of the home on East 40<sup>th</sup> St. used the retrofit as an opportunity to become net zero. They started monitoring the home's circuits to observe their consumption and to understand where a behavioral change was needed. The owners of the home on West 8<sup>th</sup> St. wanted to install



energy efficient upgrades because they thought that it was ‘the right thing to do.’ However this intention did not match their lifestyle and the technologies installed did not change the way in which they engage with their dwelling. These two case studies were very informative as they showed two projects that started with very similar intentions in the beginning. However the outcomes are quite diverse. For the first household the house became an interactive learning tool but for the second household it remained simply a showcase of good intentions.

## 5.6. Business Plan.

In conclusion, I learned that there are many obstacles that may impede a greater adoption of energy retrofits in single family homes. However the data showed that this process constitutes a great opportunity to improve efficiency and healthiness of our current homes. This research identified a series of aspects that could be modified in order

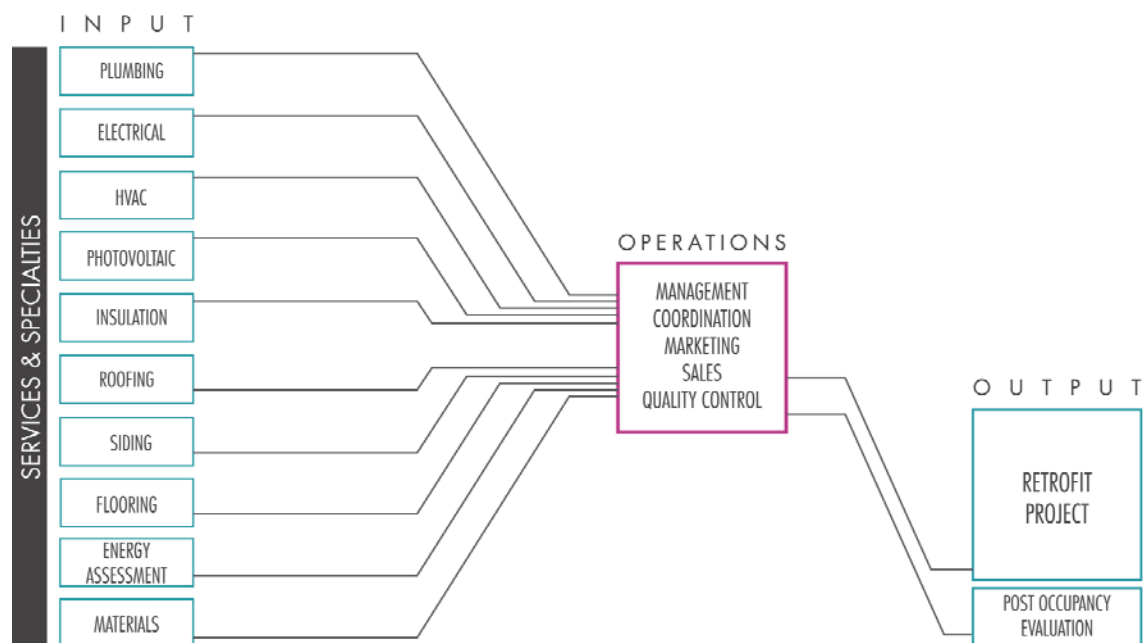


Figure 5. 1. Operational Diagram for an improved process of retrofit.

to improve the current retrofit process. The goal of the future Master of Design project is to write a business plan to put in practice what has been learned during this research. The idea is to design a process (Figure 5.1) that offers highly coordinated holistic services for energy retrofit. A central operations entity is in charge of project management, coordination, quality control, marketing, sales, branding, and so forth. A network of professionals from different specialties will be affiliated with this operation entity and will be available on a project by project basis. The output of this process will be not only the retrofit project but in coincidence with the retrofit upgrades an energy portfolio of the home will be created. The new building performance will be monitored so to offer a long lasting and continuous service of maintenance.

This process shall possess characteristics of continuity, personalization and integration. It shall aim at the betterment of our single family homes and at the same time meet the interests of homeowners, remodeling professionals, and the general public.

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School of Architecture  
The University of Texas at Austin  
Graduate Programs in Architecture and Community and Regional Planning

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**ENERGY RETOFITS IN SINGLE FAMILY HOMES, DEFINING AN  
ORGANIZATIONAL STRATEGY.**

Masters Design Study in Sustainable Design - Part B  
Chiara Bonsignori  
Master of Architecture – Post Professional  
Fall 2014

Supervisor: Dr. Steven A. Moore  
Prof. Petra Liedl



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# 1. Table of Contents

I. Table of Contents.....	1
II. Summary.....	2
III. General Company Description.....	3
IV. Products and Services.....	5
V. Marketing Plan.....	7
VI. Management and Organization.....	18
VII. Operational Plan.....	21
VIII. Financial Plan.....	22
IX. Bibliography.....	23

## 2. Summary

In this document I will define the business plan for a home remodeling company that I intend to start in the future. I will start by giving a general description of this company and of its goals. Then the marketing research relative to the remodeling industry will be presented together with the value proposition and the customer segment. Secondly I will look at the key partners and activities necessary to the success of the firm on the existing market. Lastly I will describe the financial model used (revenue stream and cost structure) and the fees proposal. As a base to develop the business plan I will use the 'canvas' model developed by Osterwalder & Pigneur (Illustration 1).

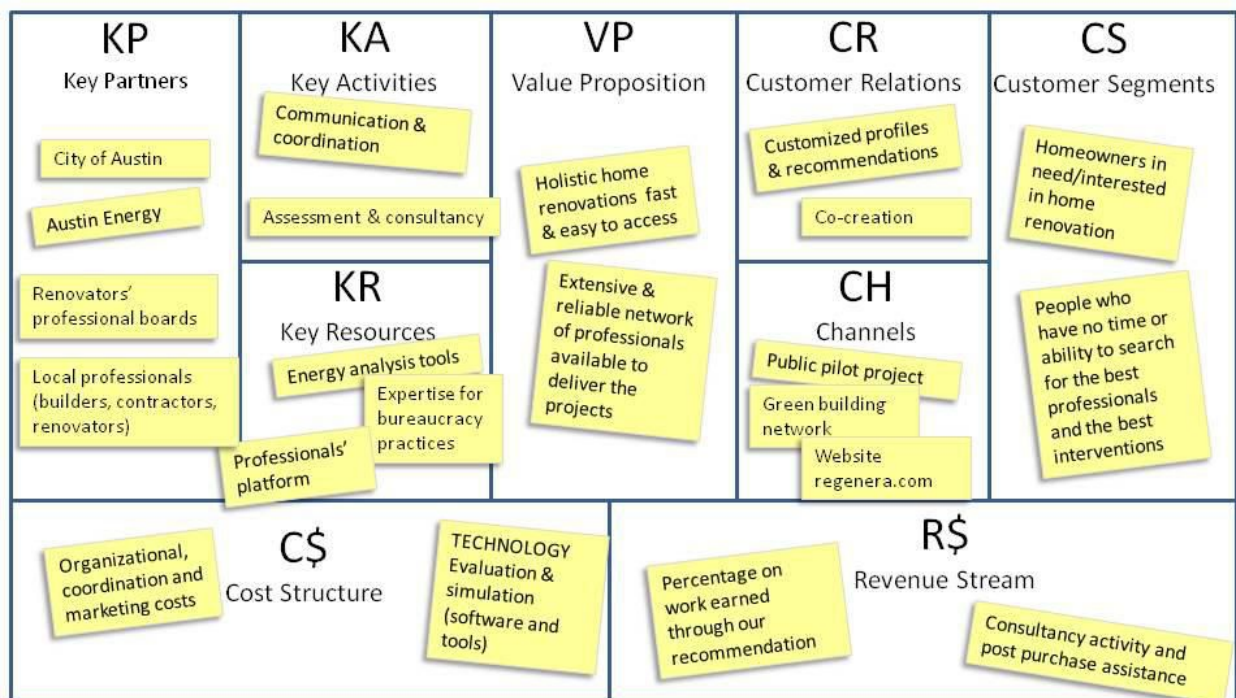


Illustration 1: The canvas model

### **3. General Company Description**

#### *3.1. Mission Statement: Goals and Objectives*

This business provides comprehensive and personalized services for residential energy retrofits. The guiding principle is the belief that there is a need to intervene more decisively on reducing homes energy consumption and carbon footprint. Our goal is to become a successful remodeling company offering comprehensive and personalized remodeling services to customers. Also we aim at building a solid reputation and trustworthy relationships with long term customers and local remodeling professionals. Our objectives are to:

- increase the number of annual remodeling interventions offering personally tailored home services like surveys and monitoring systems and comprehensive
- stabilize the presence of loyal long term customers that can attract other initially more skeptical customers to try our company.

#### *3.2. Business Philosophy*

The decision to open this type of enterprise stems from both a personal interest in architectural restoration and from the dissatisfaction with the current market of renovators and remodelers. Current data and statistics on buildings' stock in the US demonstrate that existing houses are the primary cause of energy consumption. Single family homes are highly problematic in terms of waste generation and resources consumption. As a designer highly

specialized in homes renovations I believe that sustainability must be achieved through creative ways to improve the everyday built environment.

This company has the intent to make something special with what is now regarded as banal and worthless: single family homes. Research shows that there is great need for home improvements and so this market will grow in the next years. However our goal is to set the renovations on high sustainability standards. This is a strength element as it will allow our company to benefit from the growing incentives that local administrations are setting in place to reduce CO2 emissions and energy consumption.

The chosen legal form of ownership for this company is Limited liability corporation (LLC).

This form will provide me as the business owner with liability protection and it is not subject to double-taxation. Finally, this is quite flexible when it comes to organization as it has fewer rules regarding who can be a shareholder and less formal complications are needed to run it.

## 4. Products and Services

### 4.1. *Value proposition*

The problem that we are solving with our company is accessibility to home retrofit interventions. We offer a holistic retrofit service that reduces risks and expenses for those homeowners willing to improve their homes. We do so in four ways. First we offer our design expertise to propose new solutions for each retrofit project. Second we partner with a network of subcontractors and building's experts that are specialized in different buildings systems. We select the best expertise for each intervention and coordinate the subcontractors on site. Third we have the expertise to provide help with all the bureaucracy. By being in charge of preparing the required paperwork we take away the current complexity of accessing the rebate programs offered by the City of Austin. This comprehensive strategy is innovative and currently no one is offering such a holistic service for homes retrofits. Fourth, including post occupancy evaluations and monitoring and maintenance we establish a continuous and rigorous customer service.

So to resume the values that we are offering are:

- Improvement of the home's energetic performance, and indoor quality;
- Customization of each project which will respond to the needs of individual families;
- Effectiveness since we take on all the burdens connected to a retrofit. This includes choosing the most apt professionals, coordinating the works on site and preparing the paper works for the rebates;
- Increased accessibility to retrofit and risk reduction.

#### *4.2. The new services brought by the firm. Key success factors.*

People will be interested in our services because with us the process of homes retrofit becomes easier and more understandable. Also we are unique in the way we assess the existing conditions of a house. In fact no other remodeling company evaluates utilization patterns and customers behaviors in their initial assessment of a project. Research shows that introducing social and behavioral factors leads to better results in terms of building performance and higher customer satisfaction. The high degree of coordination, the customized assessment and the creation of a long lasting trusty relationship are all elements that will give us a competitive advantage on other competitors.

## 5. Marketing Plan

### 5.1. *Market size and indicators.*

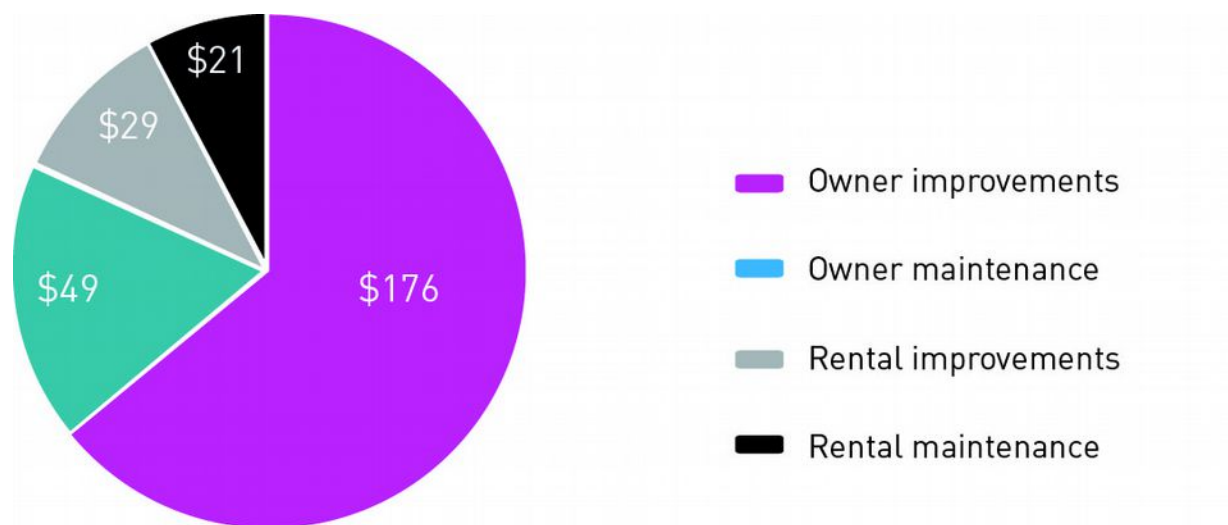
Economic indicators used as inputs in understanding the level of remodeling activity:

- National Association of Home Builders' Remodeling Market Index-Future Expectations;
- National Association of Realtors'® Pending Home Sales Index;
- Federal Reserve Board's 30-Year Treasury Bonds Yield;
- National Association of the Remodeling Industry's (NARI)
- U.S. Census Bureau's Single Family Housing Starts;
- U.S. Census Bureau's Retail Sales at Building Materials and Supplies Dealers;
- U.S. Census Bureau's Manufacturers' Shipments of Construction Materials, Wood Products and Household Appliances;
- Bureau of Labor Statistics' Number of Employees of Residential Remodelers;
- Institute of Supply Management's Purchasing Managers' Index
- LIRA (The Leading Indicator of Remodeling Activity) from JCHS

According to the Joint Center for Housing Studies at Harvard University (JCHS, 2011), "the long-term expansion of the remodeling market is an unmistakable trend, and a relatively healthy economy will assure future growth in the industry." The study cites that home appreciation, the



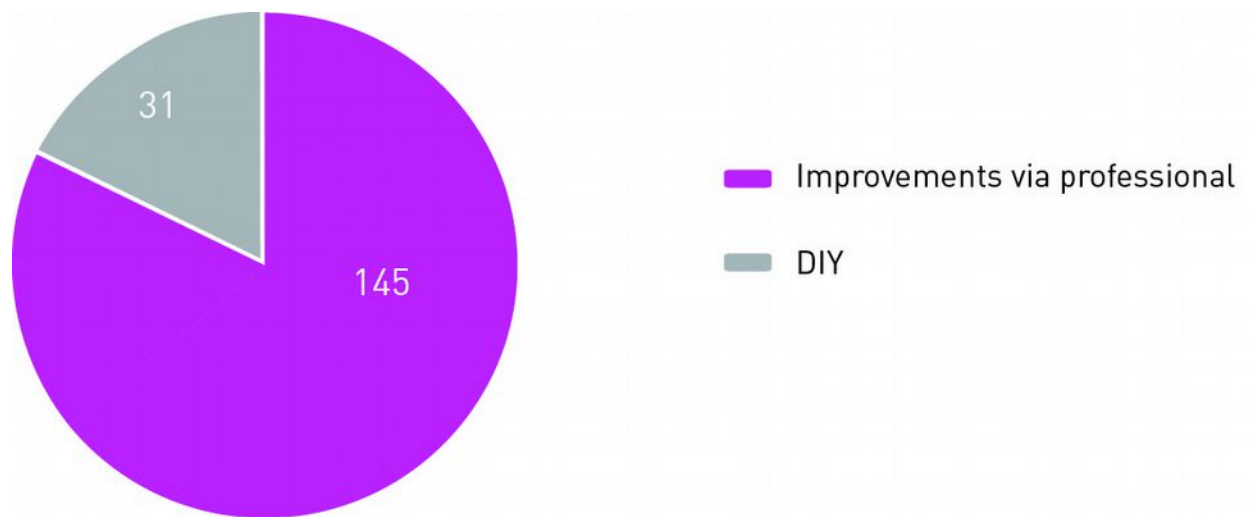
state of the broader economy and credit conditions could further reinforce and accelerate the trend. Analysis from contractors service BuildZoom (Wei, 2014) estimated that the size of the remodeling industry is now around \$300 billion annually. Other articles on Forbes (Travlos, 2013) had predicted that the better conditions of the housing industry would serve as a catalyst for the remodeling industry which would exceed \$500B in 2013. Although the Forbes numbers were slightly excessive, the trend behavioral prediction resulted accurate. As reported by BuildZoom The Joint Center for Housing Studies at Harvard University (JCHS, 2011) identified that total expenditures on improvements and maintenance to owner-occupied and rental units was about \$275 billion in 2011 (Illustration 2).



*Figure 2: Home improvement expenditures (in \$ billions). Source: JCHS*

The highest revenue, \$176 comes from the owner improvements. Of these specific expenditures about 20 percent represents DIY interventions while the rest involves the presence of a 'professional' (Illustration 3). \$29 represents the amount of expenses attributed to rental

improvements however the study does not show what percentage of this slice is attributable to professionals. Applying the ratio seen within owner expenditures, it is possible to estimate that even if the total market was close to \$300 billion in 2011, the total spent via professionals on home improvements was probably closer to \$169 billion.



*Figure 3: 2011 Owner expenditures (in \$ billions). Source: JCHS*

The National Association of the Remodeling Industry (NARI) consolidates these estimates and the positive trend of the industry. NARI's third-quarter Remodeling Business Pulse (RBP) data of current and future remodeling business conditions indicated strong growth in the third quarter of 2014 with a rating of 6.41. Quarter-over-quarter increases are evident in all sub-components measuring remodeling activity.

## 5.2. *Market characteristics*

In 2007-2009 the severe downturn in the remodeling industry had put many contractors out of business. In general, the ease of entering and exiting the industry, and the relatively high rate of failures, ensure the industry will remain dominated by small firms and self-employed contractors. We need to consider the fact that throughout time this market tends to fluctuate and that it is directly depending on the housing market and its prices. In general the studies have shown that companies of bigger sizes or that can offer a different range of services have greater chances to survive through downturns.

Yet remodeling businesses that are able to overcome these challenges enjoy significant benefits in terms of increased revenue growth and labor productivity, as well as low and stable failure rates over the business cycle. From the Joint Center for Housing Studies at Harvard University (JCHS, 2011):

- The annual share of firms exiting the remodeling industry increased from under 13% in 2004 to over 17% by 2010, compared with a failure rate of under 10% for all US payroll establishments in both years.
- Larger remodeling companies are much less likely to fail. Remodelers with estimated receipts of less than \$250,000 had a failure rate of nearly 25% in 2010, whereas the largest remodeling businesses with estimated receipts of \$1 million or more saw relatively low and stable annual failure rates over the business cycle—2.7% in 2004 and just 2.8% in 2010.

- While larger-scale remodelers were by no means immune to the business cycle, their revenues rebounded strongly after the worst of the downturn. Half of larger remodelers posted annual revenue growth of 5.1% or more in 2010 and 3.6% or more in 2011.

The above mentioned studies show the general trends of the remodeling industry and confirm that the current demand in the market is high. However these numbers refer to remodeling in an extremely broad sense (as DIY, improvements, maintenance and repair activities are all included under the same umbrella) and need to be analyzed more carefully. In fact our company is targeting a segment of the remodeling market with a strong focus on sustainability and energy efficiency.

Regarding this more specific area of remodeling the provisions seem positive too. The Joint Center for Housing Studies at Harvard University (JCHS, 2011) stated that spending on energy-efficiency upgrades, in particular, continued to expand through the remodeling downturn. “The share of total market spending on energy-related projects rose sharply from 23 percent in 2007 to 33 percent in 2011” (Joint Center’s Remodeling Futures Program) and “about a quarter of households undertaking home improvement projects in 2011 did so for energy efficiency purposes.” Local and national policies, the offer of incentives and energy saving initiatives help the growth of this segment. In fact they raise customer awareness towards homes energy performance and CO2 reductions and offer economic stimulus to undertake energy remodeling.

### *5.3. Barriers to enter the market*

This is a quite fragmented market with a variety of specialized services and high number of small competitors. We believe that very few competitors aim at offering the type of comprehensive, high quality services that we will offer. However initially it will be hard to establish ourselves as a reliable and solid company and to demonstrate in what we are different from the other competitors. High capital costs for use will be related to hire qualified and trusty workers. Marketing costs will be high, especially at the beginning. Word of mouth proved a very powerful strategy for this type of business but being a young company we will need to overcome consumer recognition issues. Primary analysis shows that many people value remodeling contractors with longevity and permanence so our goal is to become a company with a great long-standing reputation for quality and customer service.

Customer acquisition is a very important initial step for our firm. We will focus on gaining the trust of the community by creating a partnership with the City of Austin and Austin Energy. The services that we offer are based on high level personal assistance. This will help us to acquire new customers that right now are interested in retrofitting their homes but are reluctant due to lack of knowledge, uncertainties and complexity of the bureaucracy. Another strategy we will use to acquire new customers is co-creation. The homeowners will be an integrate part of the problem solving process and each design will be personalized considering the homeowner's input. When the intervention is complete we will follow up on the status of the projects. We will assist our clients with periodical monitoring and building's energy performance evaluations. In doing so we are providing a constant upgrade opportunity. This continuous post occupancy and monitoring evaluation process will guarantee a good customers' retention.

Finally, the design and consultancy services that we offer are based on a variety of expertise. Since we need different trusted contractors to execute the jobs, our activity of coordination is very complex. Therefore another barrier for our business could be represented by workforce coordination and management.

#### *5.4. Channels*

We will create awareness of our firm through public participation in the city of Austin. We will offer some free audit services and will participate on a pilot project to demonstrate how our services work. The customers can access our services mainly through the company Web site. However we will be active partners in the *Imagine Austin* initiative and in other sustainable projects that the city undertakes. Also we will be present in green building networks (LEED, USGBC...) and participate in fairs and exhibitions.

### *5.5. Product - Features and Benefits*

The company offers mainly two types of services: project development services (planning, management and consultancy) and construction services (materials and labor). The benefits offered by our company are multiple and vary depending on.

Advantages for the homeowners:

- Homeowners can utilize our database to see what qualifications the professionals in charge of their retrofit have, who they are and what they have done already in the profession. Depending on companies' availability, specialization, time of the project, budget, etc we will match the more appropriate contractor for the more appropriate project.
- Our strategy guarantees qualified workers and coordinated execution of work. Reduces unforeseen problems we can have a faster execution, minimal disruption and respect the budgeted costs.
- Additionally by being in charge of preparing the required paperwork we will take away the current complexity of accessing rebates and incentives.

Advantages for collaborators and sub-contractors:

- Being part of our network will increase their visibility and boost their revenues.
- As individual specialized entities they would not have access to bigger and more complex projects that would require the intervention of multiple coordinated skills.

- Being our partners, they will be associated with green buildings and sustainability as those are the core values for our interventions and the professionals who work with us will benefit from those labels.

### *5.6. Customers*

I identify two core customer segments of our market. One is more mass market oriented while the other is closer to a niche market. We will serve homeowners (mass market) that are in need of retrofit interventions in their homes. However at least in the first stage of our practice we will only serve a niche of homeowners that are more sensible towards the subject of energy retrofits and sustainability. So our first customers are people that are ready to invest money into some sustainability driven improvement in their homes. At a further stage we may start influence other types of homeowners so to expand our market segment.

### *5.7. Average customer profile*

- Age: 30+
- Location: Austin - Texas.
- Income level: The services target a medium-high income level customers. For Austin the middle class median household income is considered between 70K-150K (Pew Report, 2012).
- Home owners and eventually expand the service to renters. The number of home renters in Austin is already almost equal to the number of home owners and it seems to continue growing.



- Social class and occupation: middle class but no specific occupation. Most important is education and sensibility towards environmental and resources issues.

### *5.8. Competition*

In Austin there is a wide variety of specialized contractors (i.e. roof carpenters, photovoltaic installers, windows installers) that in different measures offer remodeling services. Between 30% and 40% of these declare to be oriented to energy savings and sustainability. Regardless of the quality that they can offer, the services are very specific and therefore limited. In addition they are generally small sized and short-lived companies.

However there are few companies that offer more comprehensive home renovation services.

Among our major competitors in Austin are:

- Go green squads
- Gnm Lohr Green Home builders
- CG&S
- Solluna Builders
- The Muskin company

### *5.9. Strategy - Key partners*

All the contractors working for our firm are extremely important as our reputation and credibility relies on the quality of the work that they execute. Moreover materials' producers are potentially relevant partners. They will develop new technologies that can impact the way we execute the retrofit. Finally, the City of Austin and Austin Energy will play a compelling role. The Rebates strategies and the retrofit policies that they implement or change are crucial for the development of this firm.

### *5.10. Strategy - Activities*

The activities of this firm are of different nature. Part of our energies will be focused on problem solving and consultancy. Like more traditional architecture firms we will conduct energy audits, physical assessments on site and provide design solutions for each project. Furthermore we will integrate our design activity with communication and coordination actions. The management of the professionals' network and the maintenance of the platform are imperative for the functioning of our business. Knowledge management and continuous training are crucial for the survival and adaptation of our firm in the future market. We will require our permanent employees and the subcontractors to stay updated on building technologies, sustainability and environmental issues. Milestones will be established to control the progress of each project. This will provide us and the homeowners with a clear picture of the project's status. Also, based on the milestones, invoices will be sent out to the subcontractors. These progressive steps will incentive timeliness and a smoother execution process.

### *5.11. Resources*

Our first resource is our own expertise on design and retrofit strategies. In addition the network of subcontractors, and consultants, which is what differentiates us from other competitors, is the most valuable external resource to us. Energy simulation software, smart metering and energy efficiency technologies are also highly important for our company. Up to date expertise for completing the paper works and accessing the rebates will be required too.

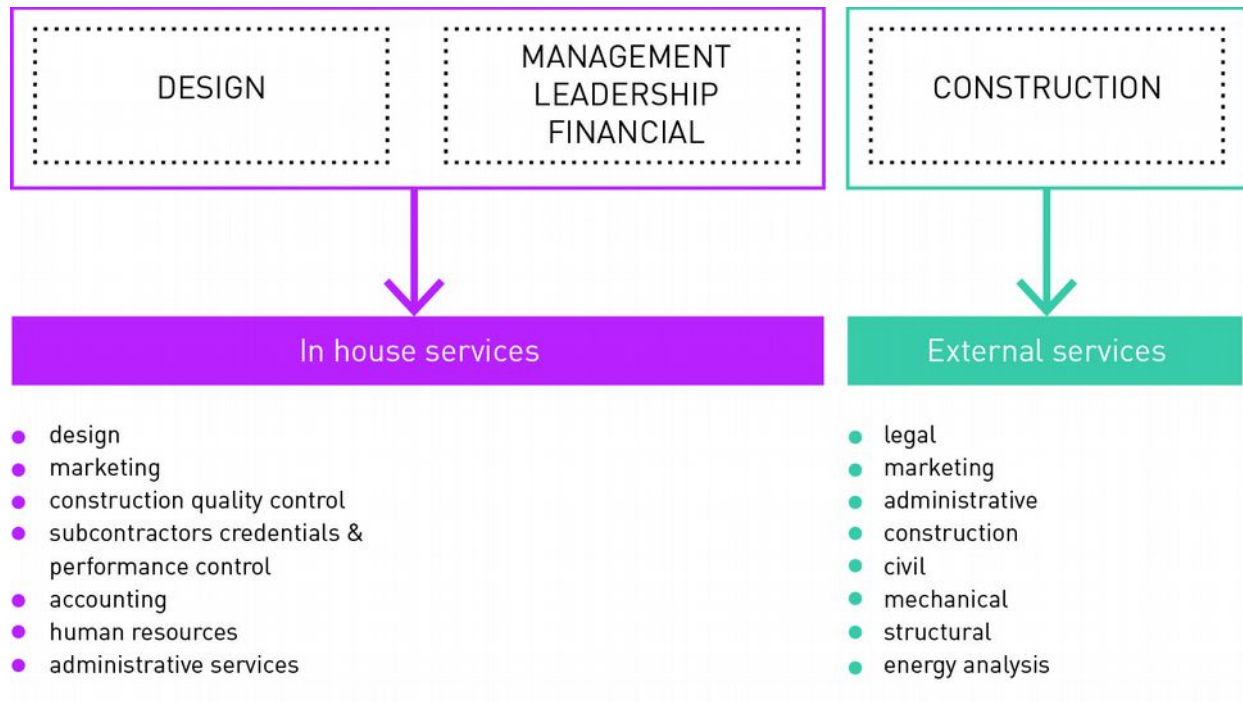
## **6. Management and Organization**

### *6.1. Company characteristics*

The first goal of this company is to establish itself as trusted firm in the specific area of sustainable homes retrofit interventions. The company will need a small space as its office. This will be a retrofitted home or part of it that could be used also as a showroom. The environment will be informal since we mainly work with homeowners and contractors. Our relationship with the clients is fundamental and gaining their trust is the most important element for us. Furthermore building honest relationships with the various professionals is fundamental for the success of our firm. We want our clients to inspire us with their particular needs and lifestyles. Each project is different in nature and scope and each technical improvement will be more likely to succeed only if the homeowner engages actively with it. We want to work close to the client to come up with creative solutions for each different need.

### *6.2. Organization*

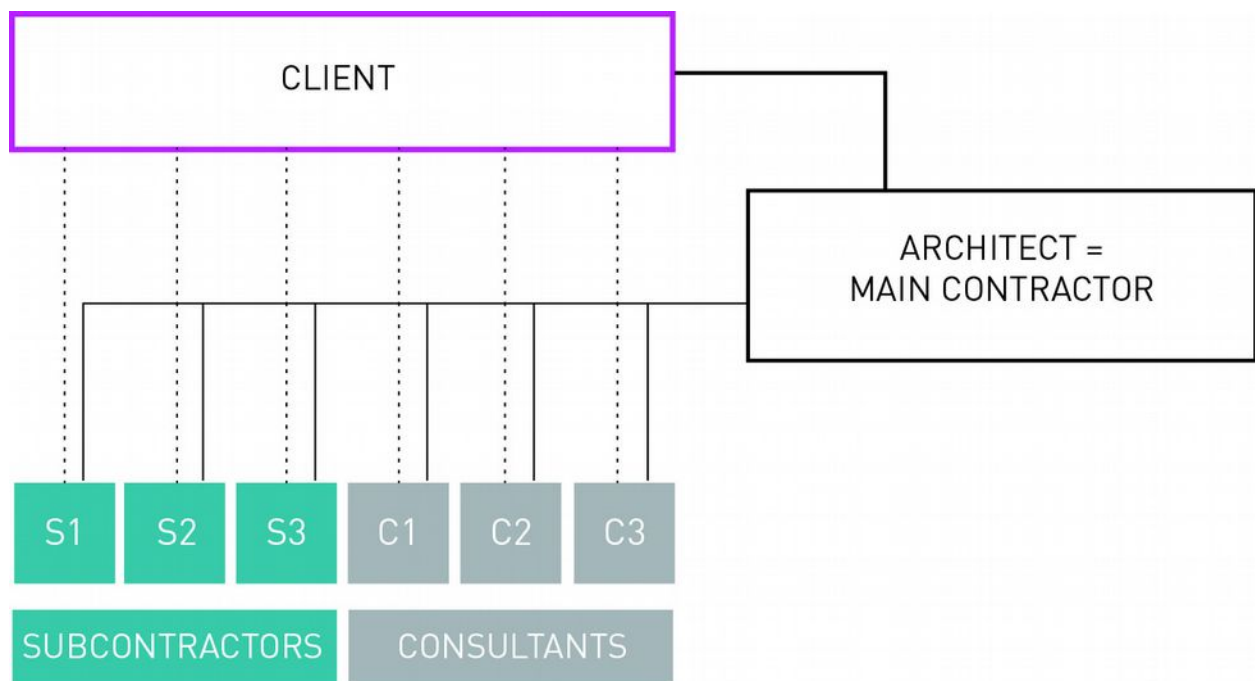
I will be the founder and principal of the company. At the beginning I do not envision the firm to reach a very large size but to employ between three and four people together with myself. Depending on the changes of the market in the Austin area and on the rebates and incentive programs we could consider increasing our size in the future. The organizational strategy is a variant of a architect-led design-build firm. We contract with the owner both for design and construction services and we procure the construction services by contracting directly with the various construction trades. The company intends to use the organizational approach of



*Figure 4: Project delivery team.*

a project delivery team. A permanent team will be in control of marketing, design, construction quality control, subcontractors credentials and performance control, accounting, human resources and administrative services. External companies will be used for additional legal, marketing and administrative support. Selected subcontractors will provide construction, civil, mechanical and structural services as needed (Illustration 4). We will select and assign them to the different projects depending on their availability and on the required skill set. We will be the main point of contact for the project and guide clients through each step of the design and construction process. However within this system the vendors contract with and are paid by the owners (Illustration 5). This strategy allows for a greater engagement of the owners in the decision-making process and it allows complete transparency in the process of contracting subcontractors. Also, it reduces the

level of risk for our company which will still be involved in the project from beginning to end as general manager and supervising entity. Through a system of invoices based on the achievement of milestones the subcontractors will be paid directly from the owners. We will recover a fee for our services as managers and coordinators. In this way our company does not need to dispose of a high capital to pay in advance the subcontractors.



*Figure 5: Firm Organization Diagram*

## 7. Operational Plan

### *7.1. Legal Environment*

Our company provides remodeling services that are personalized, meet high quality standards, respect completion schedules while remaining within budget. Additionally we are in charge of selecting and managing subcontractors. These activities carry a high level of risk as unexpected issues with the budget or with the management of the subcontractors might arise.

Since we offer guarantee of a project execution within a completion date we have to establish clauses that protect us from exceptional events (i.e. inability to obtain permits; extreme weather for long periods in time; materials required for the construction are not available) that are outside our control.

In addition we have to:

- Have a Professional Liability Insurance;
- Establish Warranties of Fitness and Guarantees of Performance and Quality;
- Consider the use of specialist Insurance markets to transfer some of the risks that arise with design/build projects;
- Guarantee our ownership of the proposed project plans and specifications;
- Define what Insurance is required under the contract and who will provide it.

- Pay attention to: Indemnification Clauses; Occupational Health and Safety Acts requirements; Waivers of Subrogation; The Limit of Liability Insurance required under the contract.

The individual subcontractors will be responsible for their own insurance. Our company will provide insurance for the permanent team and will guarantee that all the health and safety best practices on the workplace are respected.



## 8. Financial Plan

### 8.1. *Revenue stream*

The principal revenue stream is a 'brokerage fee' that comes from matching a homeowner with the different professionals available in our network. We get a percentage from the network's professionals who obtain new work through our company's recommendations. We will be in charge of design solutions and consultancy activities so another part of the revenue comes as a direct fee that customers pay to our firm. The fees for handling the paper works required will be included in that main direct fee. In the future we could think on advertising some trusted products or green materials that we utilize in our projects as additional revenue stream. However we do not intend to advertise or promote any specific professional member of our network. Include personal financial statements for each owner and major stockholder, showing assets and liabilities held outside the business and personal net worth. Owners will often have to draw on personal assets to finance the business, and these statements will show what is available. Bankers and investors usually want this information as well.

### 8.2. *Cost Structure*

For operating this business I estimate generally medium to low overhead expenses. The office space needed will be minimal. However we will need to purchase some tools and software licenses for homes assessments and energy audits. The management of the professional's platform will be an important expense to consider. Other expenses in which we will incur are the external consultancies, marketing and legal services.



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